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CERC Field Research Facility
Environmental Data Summary, 1977-79

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by

H. Carl Miller

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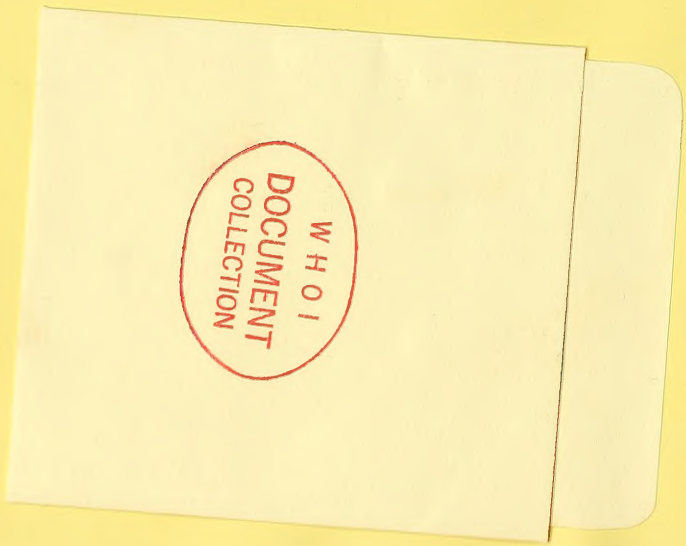

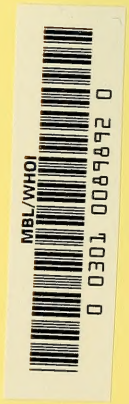

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This report, the first in a series of annual reports, provides basic data and summaries of the environmental measurements made from 1977 to 1979 at the CERC Field Research Facility (FRF) in Duck, North Carolina. The report covers two complete years, 1978 and 1979, and provides the available data from 1977.

PREFACE

This report provides basic data and summaries of the environmental measurements made at the U.S. Army Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) in Duck, North Carolina. The report, the first in a series of annual reports, covers data collected through December 1979. In the interest of making these data available, interpretation was not attempted. The work was carried out under CERC's FRF Environmental Measurements and Analysis work unit, Coastal Flooding and Storm Protection Program, Coastal Engineering Area of Civil Works Research and Development.

The report was prepared by H. Carl Miller, Oceanographer, under the supervision of Mr. C. Mason, Chief, Field Research Facility Group, and Mr. R.P. Savage, Chief, Research Division.

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Technical Director of CERC was Dr. Robert W. Whalin, P.E.

Comments on this publication are invited.

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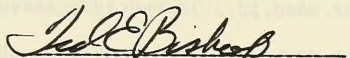

TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director

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U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

CERC FIELD RESEARCH FACILITY ENVIRONMENTAL DATA SUMMARY, 1977-79

by

H. Carl Miller

I. INTRODUCTION

The U.S. Army Coastal Engineering Research Center's (CERC) Field Research Facility (FRF), located on 176 acres at Duck, North Carolina (Fig. 1), consists of a 561-meter-long research pier and an accompanying office building. The FRF site is near the middle of Currituck Spit along a 100-kilometer unbroken stretch of shoreline that extends south from Rudee Inlet in Virginia to Oregon Inlet in North Carolina. It is bordered by the Atlantic Ocean to the east and the Currituck Sound and mainland to the west. The facility is designed to (1) provide a rigid platform for measuring waves, currents, water levels, and bottom elevations, especially during severe storms; (2) provide CERC with the field experience and data to complement laboratory studies and the evaluation of numerical models; (3) provide a manned field facility for testing new instrumentation; and (4) serve as a permanent field base of operations for physical and biological studies of the site and adjacent region.

The research pier is a reinforced concrete structure supported on 0.9-meter-diameter steel piles spaced 12.2 meters apart along the pier length and 4.6 meters apart across the width. The piles are embedded approximately 15 meters below the ocean bottom. The pier deck is 6.1 meters wide and extends from behind the dune line to about the 8-meter water depth contour, at a height of 7.8 meters above mean sea level (MSL). Concrete erosion collars protect the pilings against sand abrasion, and a cathodic system protects the pilings against corrosion.

A Basic Environmental Measurements (BEM) program has been established to collect basic oceanographic and meteorological data, which are reduced, analyzed, and the results published.

This report, the first in a series of annual reports, summarizes the results of the first two complete years (1978 and 1979) of basic measurements; available data for 1977 are also included. The report is organized such that descriptions of the instrumentation (Sec. III) and data collection and analysis procedures (Sec. IV) precede reporting of the data (Sec. V). Section VI describes the procedure for obtaining additional data. Although this is intended as a stand-alone document, references should be consulted for details of some procedures and instrumentation.

Future annual reports will have approximately the same format, but an interpretation of the data will be included. Readers' comments on the format and usefulness of the data presented are encouraged.

In addition to the annual reports, monthly data reports summarizing the same types of data shortly after the data are collected will be available upon request.

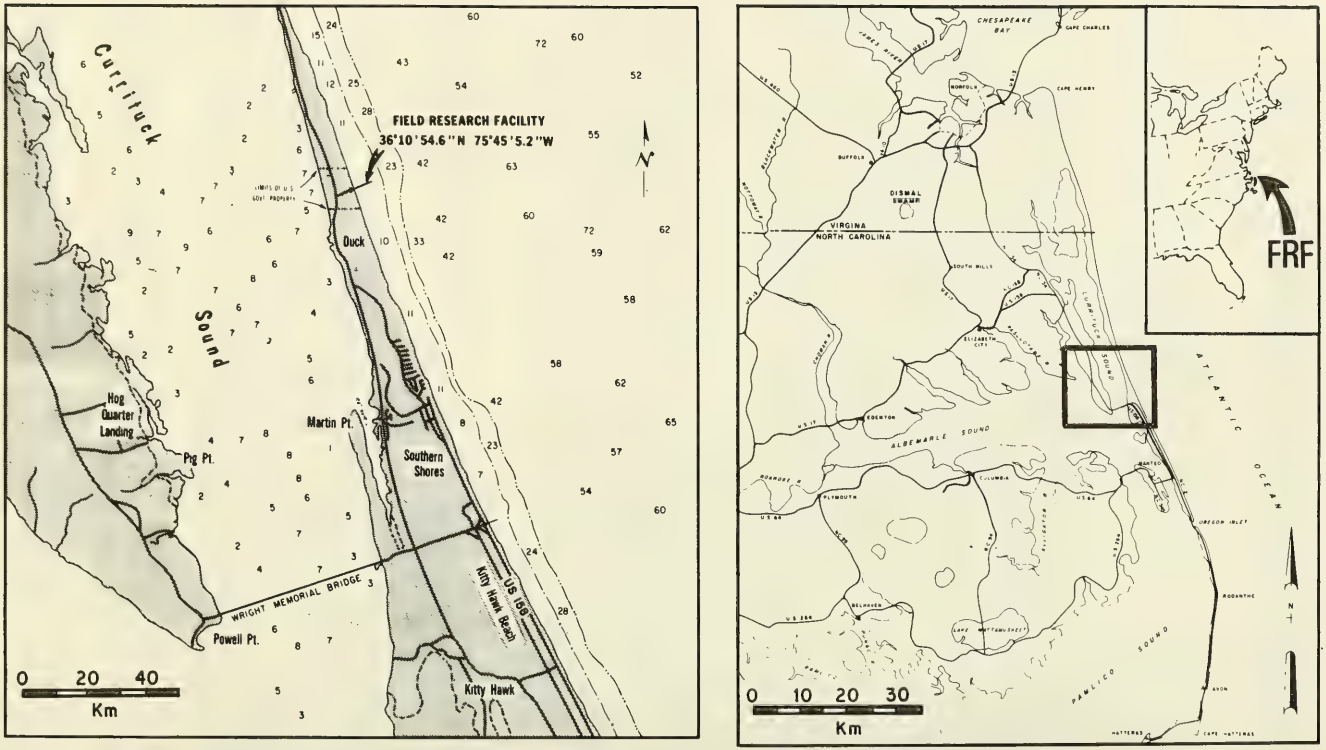


Figure 1. FRF location map.

II. CLIMATOLOGICAL SUMMARY

This section briefly summarizes the environmental conditions at the FRF during the reporting period; complete tabulated summaries are contained in Section V.

The maritime climate at the FRF tends to moderate the seasons with winters that are warmer and summers that tend to be cooler than on the mainland. Large temperature differences between day and night occur during late fall and spring due to the slow response of the ocean to changing temperature trends and frequent land and sea breeze effects. Air temperatures at the FRF during 1978 and 1979 varied from a low of -7.8° Celsius in February 1979 to a high of 43.3° Celsius in July 1979. The annual average temperature was slightly less than 16° Celsius.

The precipitation was fairly well distributed throughout the year with a monthly average of approximately 100 millimeters. May was the wettest month, while August and October were the driest.

Although warm in the summer and chilly in the winter, the sea breeze at the FRF is persistent; seldom is there a dead calm. On occasion, severe winds blow as a result of either extra-tropical (northeasters) or tropical (hurricanes) cyclones. The winds at the FRF are predominantly from the southwest. Summer winds from the southwest frequently shift clockwise to the easterly directions; winter winds are more often from the north and east, resulting from arctic highs and tropical low-pressure systems that originate in the Caribbean and move north along the coast. The winds in 1978 were predominantly from the southwest and northeast, while in 1979 there was more of a southwest and northwest tendency. Extreme winds were generally from the northeast. Although the FRF was not directly hit by a major hurricane in 1978 and 1979, strong northeasters produced high winds of more than 10 meters per second in April 1978, February and December 1979.

Although wave approach during the overall reporting period was predominantly from the south side of the FRF pier, during the winter months (October through March) when the largest waves occurred a far greater percentage approached from the north side of the pier. The average and the standard deviation of the annual significant wave height, measured at the seaward end of the FRF pier (median depth 8 meters), were 1.0 and 0.5 meter, respectively, while the average annual significant wave period was 8.9 seconds with an associated standard deviation of 2.6 seconds. The highest significant wave height recorded was 3.3 meters in April 1978.

The average tidal range during the reporting period was slightly more than 1 meter for the pier-end tide gage. The highest recorded water level was 127 centimeters above the 1929 National Geodetic Vertical Datum (NGVD), which occurred on 13 September 1979 during high wave conditions; the lowest water level recorded was -95 centimeters below NGVD on 6 September 1979. The annual (1979) average mean high water (MHW) and mean low water (MLW) levels were 60 and -43 centimeters (NGVD), respectively.

The annual variation of the location of the MSL beach intercept covered a 34-meter range with the extreme positions being as near as 32 meters from the dune on 30 November 1979 and as far as 66 meters from the dune on 17 August 1979.

The nearshore bottom elevations along the north side of the FRF pier varied as much as 3.3 meters at pier station 6+51, located 130 meters seaward of the dune, and as little as 0.5 meter at pier station 12+47, some 312 meters from the dune.

III. INSTRUMENTATION

This section identifies the instruments used for the long-term monitoring of oceanographic and meteorological conditions, and briefly describes their design and operation. More detailed explanations may be found in Miller (1980). The equipment used for collecting other types of data (e.g., surveying system) is discussed in Section IV.

1. Wave Gages.

Five wave gages are in operation as part of the BEM for monitoring the wave conditions in the vicinity of the FRF (Fig. 2). These include a wave staff gage on Jennette's Fishing Pier in Nags Head, North Carolina, approximately 40 kilometers south of the FRF; two wave staff gages on the FRF pier (one at station 6+20, the other at station 19+00); and two Waverider buoy gages located 0.6 and 3 kilometers offshore.

The wave staff gages are parallel cable types manufactured by the Baylor Company, Houston, Texas. These gages are designed for an accuracy and resolution of 1 and 0.1 percent full scale, respectively. The Waverider buoys are manufactured by the Datawell Laboratory for Instrumentation, Haarlem, Netherlands. The 0.7-meter-diameter buoy floats on the water's surface and measures the vertical acceleration produced by the passage of a wave; the buoy electronics doubly integrate this signal to produce a displacement signal and telemeter the signal to a receiver onshore. The manufacturer states that wave amplitudes are correct within 3 percent of their true value for frequencies between 0.065 and 0.5 hertz (i.e., wave periods between 15 and 2 seconds). For frequencies as low as 0.03 hertz (i.e., a 33-second period), the manufacturer provides a frequency response curve which must be used to maintain the 3-percent accuracy. The frequency response curve was not used for the data in this report; wave periods greater than 15 seconds were noted in less than 2 percent of the Waverider observations.

2. Tide Gages.

Water level data from two gages located on the FRF pier are presented in this report. The National Oceanic and Atmospheric Administration (NOAA), National Ocean Survey (NOS), control station at the seaward end of the research pier (station 19+60) consisted of a Leupold-Stevens gage manufactured by Leupold and Stevens, Inc., Beaverton, Oregon. The nearshore station along the pier (station 7+20) consisted of a Fischer-Porter gage manufactured by Fischer and Porter Company, Warminster, Pennsylvania. Both the Leupold-Stevens and Fischer-Porter analog-to-digital recorders are float-activated, spring-counterbalanced instruments that mechanically convert the vertical motion of a float into a coded, punched paper-tape record. The below-deck installation at stations 19+60 and 7+20 consisted of 30.5-centimeter-diameter stilling wells with a 2.5- and a 1.3-centimeter orifice, respectively, and 21.6-centimeter-diameter floats.

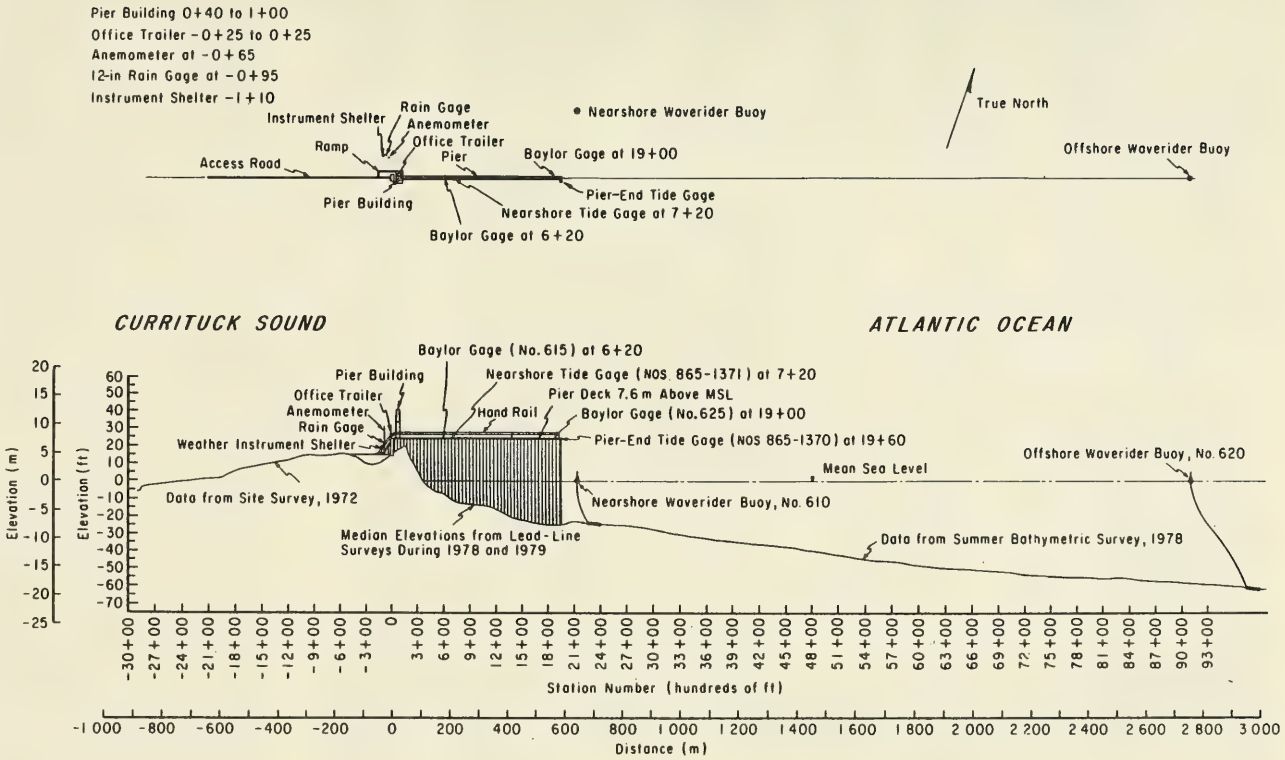


Figure 2. Location of FRF instrumentation.

3. Meteorological Instruments.

a. Anemometer. Winds were measured using a National Weather Service (NWS) Model F420C anemometer, which consisted of a cup rotor and spread-tail wind vane. The anemometer was located 58 meters behind the dune with the cups 6.4 meters above NGVD (Fig. 2). The accuracy of the speed transmitter and indicator assemblies is 0.05 meter per second up to 5 meters per second and 0.1 meter per second from 5 to 10 meters per second. The wind direction transmitter and indicator assemblies are accurate to ±5° at an airspeed of 0.26 meter per second or greater.

b. Microbarograph. This recording instrument is an aneroid sensor used to measure atmospheric pressure and responds to pressure changes on the order of 0.169 millibar. The microbarograph, which is manufactured by the Belfort Instrument Company, Baltimore, Maryland, was located inside the office trailer, 8.5 meters above NGVD (Fig. 2).

c. Maximum-Minimum Thermometers. These thermometers were housed in the instrument shelter and were used to determine the daily extreme temperatures.

d. Rain Gage. A 30-centimeter weighing rain gage manufactured by the Belfort Instrument Company was used to measure the daily amount of precipitation. The gage was located near the instrument shelter 87 meters behind the dune (Fig. 2). The manufacturer's specifications indicate that the instrument accuracy is ±0.5 percent for precipitation amounts less than 15 centimeters, and ±1.0 percent for amounts above 15 centimeters.

e. Sling Psychrometer. A sling psychrometer was used to measure "wet" and "dry" bulb temperatures for determining relative humidity and dewpoint. The psychrometer has two thermometers mounted in a frame which is rotated rapidly. A moistened muslin wick is attached to the bulb (which is then the wet bulb) of one of the thermometers and the device is whirled to ventilate both thermometers. The wet and dry bulb temperature readings and a set of NWS tables are used to determine the dewpoint.

f. Pyranograph. A mechanical pyranograph, manufactured by the Weather Measure Corporation, Sacramento, California, was located on the top of the weather instrument shelter and provided a record of the duration and intensity of solar radiation.

IV. DATA COLLECTION AND ANALYSIS

This section discusses the FRF data collection techniques, data acquisition systems, and data analysis procedures, as well as quality control measures.

1. Digital Wave Data.

a. Recorders and Signal Conditioning. Two different recording systems were used to collect digital wave data. The primary system transmitted analog data signals via telephone lines from the FRF to CERC at Fort Belvoir, Virginia. Data were recorded in digital form on a Modcomp II/25 minicomputer. The backup system recorded data at the FRF using a Lockheed Store 7 (FM) recorder. A second FM recorder, which was located at CERC (Fort Belvoir), was

used to play these tapes into the Modcomp so that the data record could be digitized and tapes compatible with the telephone-line system generated. From August 1978 through September 1979, the Modcomp was not operational; consequently, only the FM recorder was used for data collection.

Regardless of which system was used, the voltage signal from the sensors required certain conditioning. For the Modcomp system, the signal was first amplified and biased to ensure a 0- to 5-volt range, then converted to a frequency-modulated signal by exciting a voltage controlled oscillator (VCO). That signal was then transmitted to Fort Belvoir via telephone line where a discriminator was used to convert back to a voltage signal. This signal was fed into a demultiplexer to convert to a serial data stream which was then sampled by the Modcomp. For the FM recording system, the 0- to 5-volt signal was fed directly to the FM recorder which operated on a maximum output of 3 volts; thus it linearly scaled the 0- to 5-volt signal by a factor of 3/5.

b. Data Collection. The signals from the BEM wave sensors were sampled four times per second for 20 minutes every 6 hours, beginning as near as possible to 0100, 0700, 1300, and 1900 hours eastern standard time (e.s.t.). These hours correspond to the times used for the NWS daily synoptic weather maps. Since the Modcomp system was automated, data were recorded during nonduty hours and on weekends-holidays. The FM recorders were run manually and for most dates only two observations, one in the morning and one in the afternoon, were obtained. In general, the FM recorder was not run on the weekends and holidays unless there was a particular event in progress, such as a storm or experiment. If raw data records are to be obtained from CERC, it is important to determine which recording system was used since the digital data from the FM system require a 5/3 amplification to exactly duplicate the scale of the data recorded via the telephone-line system.

The Baylor wave staff gages required little maintenance except to keep the biological growth cleaned off the cables and to replace defective parts, e.g., transducers after a lightning strike. The staff gages including the transducer elements and associated electronics were calibrated at least once a year and each Baylor transducer element was calibrated prior to installation (see App. A for gage histories and the dates new transducers were installed). Recent tests indicate that gage calibrations performed this often ensure accurate wave height information but that the amplification electronics should be checked and adjusted at least monthly to obtain accurate water level information from the staff gages.

At least every 9 months the two Waverider buoy gages were rotated with two that had been cleaned, repainted, and new batteries installed. CERC did not calibrate the buoys during 1978 and 1979; however, recent semiannual calibrations of the same buoys show an 8-percent or less amplitude response error in the 10-second period range when compared to the manufacturer's calibration curve. The Datawell Company believes this has been a gradual deterioration of the accelerometer system that started when the buoy was initially put into service; thus, there is reason to believe that during 1978 and 1979 the error was considerably less than 8 percent.

c. Data Tapes. The wave data from January 1977 through December 1979 were recorded in digital form in the following basic tape format: two records of header information which included the station identification number, the

date and time, followed by a variable number of records necessary to obtain 20 minutes of data from all sensors at a sample rate of four values per second. Each record contained 384 20-bit integer words (i.e., binary format). Each integer word represented the computer units corresponding to the instantaneous voltage output of the sensor. The above sequence of records was repeated for each recording interval until the data tape was filled.

The 20-bit word size is unusual but necessary because CERC processes the data on a CDC6600 machine which has a 60-bit word size. CERC has the software to convert the data tapes to an ASCII format.

d. Data Analysis and Summarization Procedures. The CERC procedure for analyzing and summarizing digital wave data is based on a fast Fourier transform (FFT) spectral analysis procedure. The final results are also subjected to an editorial review and quality control before public distribution (Harris, 1974; Thompson, 1977). The computer analysis routine uses 4,096 data points (1,024 seconds of data sampled four times per second) for each data record processed. The program first edits the digital data record, checking for nonnumeric characters, jumps, and spikes (i.e., deviations greater than 2.5 and 5 standard deviations from the mean, respectively). If more than five bad data points are found in a row or more than 2.5 percent of the digital values are determined to be bad, the record is considered unsuitable for analysis and rejected. For a few bad data points, the routine will linearly interpolate between the erroneous values. If the record is determined to be suitable for analysis, the distribution function of the sea-surface elevations and the first five moments are computed. The variance (the second moment) and skewness (the third moment) are checked to determine if full analysis of the data record is warranted. Records with very low variance values and excessively skewed distribution functions are not fully analyzed. After it is determined that the record justifies full analysis, a cosine bell data window is applied to increase the resolution for the energy spectrum of the record; use of the data window is discussed by Harris (1974). After application of the data window, the program computes the variance spectrum (energy spectrum) using the FFT procedure.

Significant wave height and peak spectral (or significant) period values conveniently characterize the wave conditions contained in the data record and are more conducive to statistical summarization than the more complete but complex description provided by the spectrum. Although significant wave height is defined as the average height of the highest one-third of the waves in a record, experimental results and calculations based on the Rayleigh distribution function show that the significant height is approximately equal to four times the standard deviation of the wave record (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1977). The peak spectral wave period (also referred to as the significant or peak period) for each digital record is defined as that period associated with the maximum energy density in the spectrum (Thompson, 1977).

After 1 month of data has been analyzed, the significant wave height and peak period values are segregated by gage and tabulated for an editorial review. The editor checks for such things as unreasonable distribution of the sea-surface elevations; clipping of the crest or troughs; inconsistencies between successive observations; large trends in the 17-minute, 4-second data record; and discontinuities in the data. After the data are edited, two-page monthly summaries of significant height and peak period are generated for inclusion in monthly reports.

2. Water Level Data.

a. Data Collection. The water level information was obtained from two NOS tide gages, each of which produces a digital paper tape of instantaneous water levels sampled continuously at 6-minute intervals. At the end of each month, the paper-tape records are removed from the recorders and mailed to NOS in Rockville, Maryland, for analysis.

The FRF tide gages are checked daily for (1) the correctness of time, (2) the proper operation of the punch mechanism, and (3) the accuracy of the water level information obtained. The accuracy is determined by comparing the gage level reading to a level read from a reference electric-tape gage.

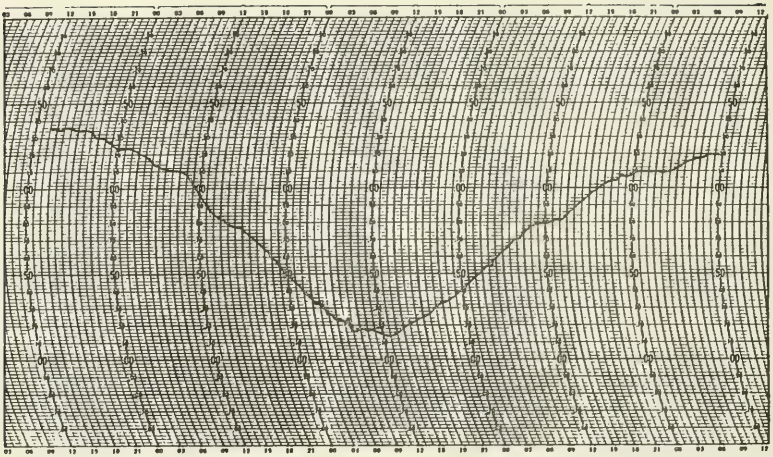
b. Data Analysis. The digital paper-tape records of tide heights taken every 6 minutes were analyzed by the NOS Tides Analysis Branch. A Mitron interpreter created a digital magnetic computer tape from the punched paper tape. This tape was then processed on a Univac 732 computer. First, a listing of the instantaneous tidal height values is obtained for a manual check. If errors are encountered, the computer program can fill in or re-create a maximum of 3 consecutive days of bad data using correct values from the nearest tide station and accounting for known timelags and elevation anomalies. The data are plotted and a new listing is generated and rechecked. When the validity of the data is confirmed, monthly tabulations of daily highs and lows, hourly heights (instantaneous height selected on the hour), and various extreme or mean water level statistics are generated. The MSL reported is the average of the hourly heights throughout the month; the mean tide level (MTL) is midway between MHW and MLW.

3. Weather and Visual Observations.

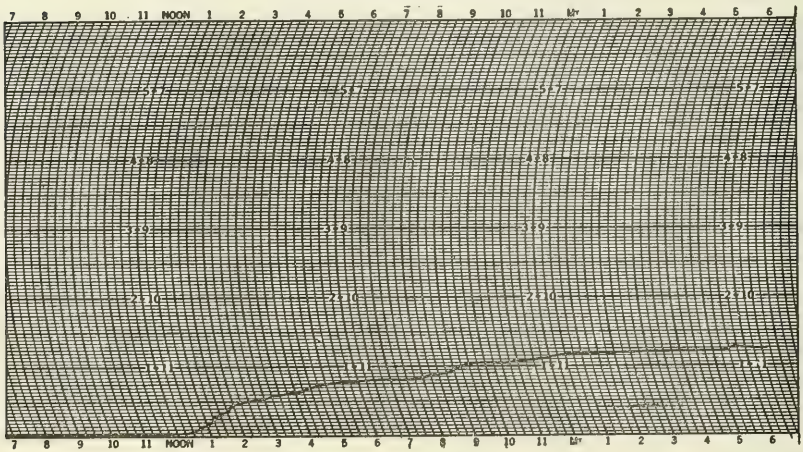
a. Meteorological Data. Each instrument that is used for monitoring the meteorological conditions at the FRF is read and inspected daily. The instruments with analog chart recording capabilities are checked as follows: the chart pen is zeroed; the chart time is checked and corrected if necessary; a daily reading is marked on the chart for reference; the starting and ending chart times are recorded as necessary; and new charts are installed when needed. Sample chart records for the barograph (atmospheric pressure), rain gage, and pyranograph (solar radiation) are presented in Figure 3. Daily readings are taken from all instruments except the pyranograph. Visual observations of weather information such as cloud cover, visibility, and predominant weather conditions are obtained concurrently with the instrument readings.

The meteorological data summaries in this report were prepared from daily observations obtained at about 0700 e.s.t. These summaries do not represent daily or hourly averages; therefore, caution should be exercised when interpreting the results.

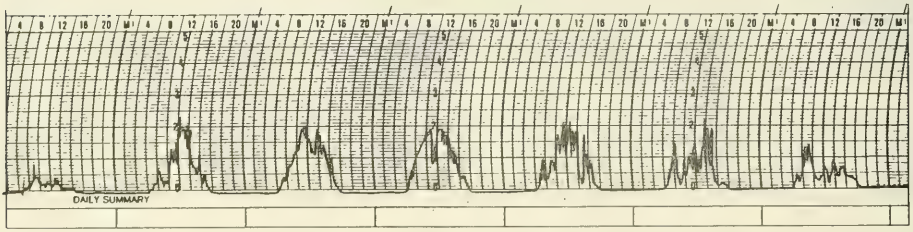
The NWS anemometer was calibrated annually. The anemometer output was coupled to dial wind speed and direction indicators, which were read daily (estimated averages of a 1-minute observation of the dials).



a. BAROGRAPH SAMPLE



b. RAIN GAGE SAMPLE



c. PYRANOGRAPH SAMPLE

Figure 3. Samples of meteorological instrument chart records.

An aneroid barometer that was calibrated in 1977 was located near the microbarograph and used as a standard for daily comparisons with the microbarograph.

b. Littoral Environmental Observations. Visual observations conforming to CERC's Littoral Environmental Observation (LEO) program (Schneider, 1981) were obtained daily at about 0700 to supplement instrumented data collection. These included observations of surface current speed and direction and wave approach angle.

4. Sediment Data.

a. Data Collection. Weekly samples of the surface layer (top centimeter) of sand were taken by hand from the foreshore near the upper swash limit, and a detailed sediment survey was performed in August 1979 to obtain data on sediment characteristics both alongshore and perpendicular to shore at the FRF. The survey, which was conducted by divers using a 40-centimeter-long coring device, covered an area 76 meters north and south of the pier from the dune to a 16-meter water depth, i.e., 3300 meters offshore.

b. Data Analysis. The August 1979 survey data and the foreshore sampling data prior to April 1978 were analyzed with CERC's rapid sediment analyzer to determine the size distribution of the samples (Duane and Meisburger, 1969). Foreshore sand samples taken after April 1978 were visually compared to 0.5-phi interval size standards to determine an approximate mean grain diameter. The phi designation is defined as minus the log to base 2 of the sediment diameter in millimeters, i.e., phi = $-\log_2(\text{dmm})$.

5. Beach, Bathymetric, and Pier Surveys.

a. Data Collection. In September 1978, the beach in the vicinity of the FRF was surveyed using conventional rod and stadia techniques (Czerniak, 1972). This technique permits rapid data collection with accurate results conforming to the following specifications: horizontal accuracy ±15 centimeters; vertical accuracy ±0.3 centimeter. The surveys went from the monument base line behind the dune to a maximum wading depth of approximately -0.5 meter MSL.

In October 1979, Langley and McDonald, Inc. of Virginia Beach, Virginia, performed a FRF bathymetric survey that covered the beach, nearshore, and offshore areas. Survey ranges were located up to 4 kilometers north and south of the pier; each range extended seaward from the base line behind the dune sometimes as far as 3200 meters offshore. Range designations and locations are given in Table 1. The survey techniques used were as follows:

(a) For beach surveying, the conventional rod and stadia technique as described above was used. Control consisted of a series of monuments installed by NOS, CERC, and the U.S. Army Engineer District, Wilmington (SAW); Czerniak (1974) provides documentation on almost all control in the area. The beach part of the survey went from the monument base line behind the dune to the maximum wading depth (approximately -0.5 meter MSL).

(b) For nearshore surveys, the contractor used a stadia rod mounted on a sea sled (Fig. 4) to conduct surveys through the surf zone. The sled was pulled offshore by boat and then winched by cable to shore. The cable was marked at 6.1-meter intervals and an observer on the beach used a level to read the rod elevation at each interval as the sled was winched to shore.

Table 1. Ranges used in 1978 and 1979 surveys.

Range No.	Prior designation	Distance from ℄ of pier (m)	Year conducted (1978)	(1979)
25	A	-3810	x	x
30	CERC 3	-2677	x	x
40	CERC 4	-1667	x	
50	CERC 5	-905	x	x
Temp		-775		x
Temp		-650		x
60	CERC 6	-524	x	x
70	CERC 7	-333	x	x
80	CERC 8	-238	x	x
100	CERC 10	-167	x	x
130	CERC 13	-131	x	
150	CERC 15	-98	x	
160	CERC 16	-48	x	x
162	B	-23	x	
168	C	23	x	x
170	CERC 17	48	x	
173	D	98	x	x
175	E	122	x	
176	SAW 12+00	151	x	x
180	CERC 18	238	x	x
183	SAW 6+00	334	x	x
187	SAW 1+50	471	x	x
190	CERC 19	619	x	x
Temp		750		x
Temp		900		x
207	F	2286		x
220	CERC 22(G)	3834	x	x

NORTH

SOUTH

Figure 4. Sea sled used in the 1979 bathymetric survey.

(c) For offshore surveying, the contractor used a large fishing (sport) boat with an analog fathometer; two people on shore triangulated the boat's position. The fathometer was calibrated on each range line by comparing the value at the sea sled's seawardmost position. The range, angle, and depth information was correlated and manually reduced to produce position and depth data.

In addition to the beach and bathymetric surveys, weekly profiles along both sides of the pier were performed, using the "lead-line" surveying technique which consisted of lowering a weighted measuring tape and noting the distance below the pier deck which is a known elevation above NGVD. Spaces between the pier bents (i.e., every 12.2 meters) were used to minimize inaccuracies due to scour near the pilings.

b. Data Analysis. Surveying conditions were calm in 1979 and no correction for wave effects was made by the contractor for the offshore part of the bathymetric survey. An output of the data for the pier, beach, nearshore, and offshore sections of each range is generated and a graph of the profiles (i.e., distance along the range versus elevation) is provided, using line printer graphics, for visual inspection. After the data are edited and determined to be acceptable, another set of computer routines is used to generate various statistics, e.g., maximum and minimum sand elevations, and various graphic displays, e.g., profile representation, contour movement, envelope of elevations, and time sequence of elevations.

6. Photography.

a. Aerial. Several aerial photography missions were performed by a contractor as part of the BEM, using a 9-inch negative format mapping aerial camera for both black and white and color photography. All coverage had at least a 55-percent overlap, and all flights were flown as close as possible to periods of low tide between 1000 and 1400 hours with less than a 10-percent cloud cover. The flight lines were concentrated near the FRF although one flight line per year extended from Cape Henry, Virginia, to Cape Hatteras, North Carolina (see Fig. 5). The flight dates and scale specifications are described in Table 2.

b. Ground. As part of the visual observations, color slides of the beach were taken daily from the pier looking north and south, starting in August 1979. The location from which the picture was taken, the date, the time, and a brief description of the picture are marked on the slides, and an inventory is maintained.

V. RESULTS

Although this report is intended to provide basic data for analysis, many of the daily observations have been summarized by month, season, or year to aid in interpretation. Where summaries appear and no individual data are included in the report, users may obtain the detailed information by following the procedures described in Section VI.

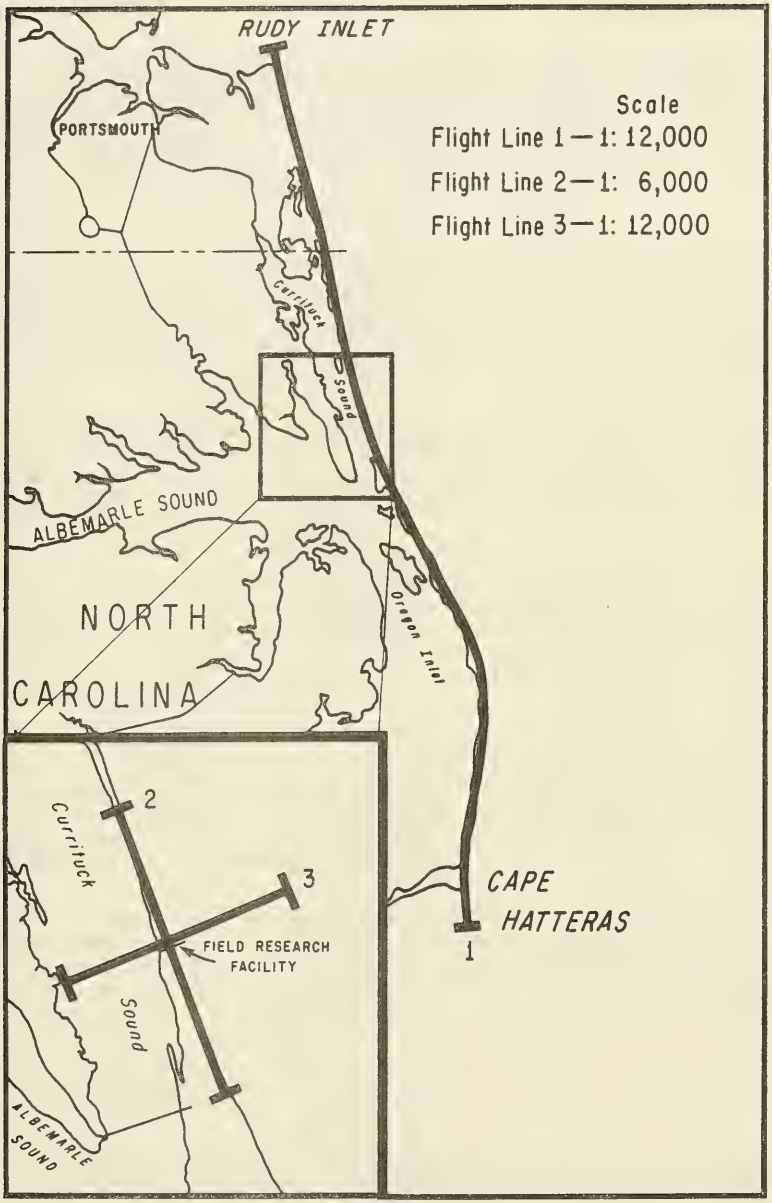


Figure 5. Flight lines for aerial photography missions.

Table 2. Flight dates and aerial photography inventory.

Date	Flight line 1: Cape Hatteras, N.C. to Cape Henry, Va. (scale 1:12,000)	Flight line 2: Duck, N.C. (scale 1:6,000)	Flight line 3: Currituck Sound to Atlantic Ocean (scale 1:12,000)	Film format (negatives)
2 Feb. 1977	10 mi (16 km) north of FRF to Oregon Inlet	2 mi (3.2 km) north to 2 mi south of FRF pier		Color
29 July 1977	10 mi north of FRF to Oregon Inlet	2 mi north to 2 mi south of FRF pier		Color
10 Aug. 1977	10 mi north of FRF to Oregon Inlet	2 mi north to 2 mi south of FRF pier		Color
11 Nov. 1977	10 mi north of FRF to Oregon Inlet	2 mi north to 2 mi south of FRF pier		Color
8 Feb. 1978	10 mi north of FRF to Oregon Inlet	2 mi north to 2 mi south of FRF pier	Currituck County to Atlantic Ocean	Color
16 May 1978	Cape Hatteras to Cape Henry	5 mi (8 km) north of FRF to 5 mi south (scale 1:6,000); 3 mi (4.8 km) north of FRF, 3 mi south (scale 1:2,200)	Currituck County to Atlantic Ocean	Black and white
13 Sept. 1978	2 mi north of FRF to Oregon Inlet	2 mi north of FRF to 2 mi south (scale 1:6,000)		Black and white
18 Oct. 1978	Cape Hatteras to Cape Henry			Black and white
2 Dec. 1978	Cape Hatteras to Cape Henry		Currituck County to Atlantic Ocean	Black and white
21 Apr. 1979	Cape Hatteras to Cape Henry (scale 1:12,000)	2 mi north of FRF to 2 mi south (scale 1:6,000)	Currituck County to Atlantic Ocean (scale 1:12,000)	Black and white
		2 mi north of FRF to 2 mi south (scale 1:9,000)		Color IR
2 Sept. 1979	Cape Hatteras to Cape Henry (scale 1:12,000)	2 mi north of FRF to 2 mi south (scale 1:6,000)	Currituck County to Atlantic Ocean (scale 1:12,000)	Black and white
		2 mi north of FRF to 2 mi south (scale 1:9,000 and 1:2,300)		Color IR
25 Oct. 1979		2 mi north of FRF to 2 mi south (scale 1:6,000)	Currituck County to Atlantic Ocean (scale 1:12,000)	Black and white
		2 mi north of FRF to 2 mi south (scale 1:9,000)		Color IR

1. Data Availability.

Tables 3, 4, and 5 are quick reference guides showing a weekly breakdown of the various types of data available for 1977, 1978, and 1979, respectively. Wave instrument histories, which are provided in Appendix A, may explain major gaps in the data. Detailed listings of available analog chart records for the meteorological instruments are provided in Appendix B.

2. Wave Data.

Appendix A contains significant wave height and peak period summaries for each BEM wave sensor which include (a) the gage history; (b) a table of overall, annual, and monthly maximums, means, and standard deviations of significant wave height and peak period; and (c) tables of the joint distribution of significant height versus peak period for the overall time of operation.

Figures 6 and 7 present the extreme, mean, and standard deviation of the mean significant wave height values for those months where at least 50 percent of the observations were obtained from the Nags Head and pier-end staff gages, respectively. Thompson (1977) used the 50-percent cutoff to ensure the reliability of data summaries.

Table 6 is an annual joint distribution of significant height versus peak period for the Nags Head gage during 1977. This table gives the frequency of the significant wave height and peak period within specified intervals, based on the number of observations per 1,000 observations. These values can be converted to percent by dividing by 10. A detailed explanation of the table format is provided in Appendix A.

Tables 7 and 8 show the same type of distributions during similar times of operation in 1978 for the nearshore (615) and pier-end (625) staff gages. The data in these tables are relatively incomplete and should not be used for determining annual trends; the tables are included to emphasize differences between the pier-end and nearshore locations.

Figure 8 shows the annual cumulative significant height distributions for a relatively complete year of data from Nags Head during 1977 and from the FRF pier-end staff gage during 1978. Figure 9 shows the typical distribution of peak wave periods during the same years of data; a solid line histogram represents the 1977 data for Nags Head and a symbol indicates the 1978 data for the pier-end Baylor staff gage.

3. Tides and Water Levels.

The history of tide gage operations for the two FRF installations is provided in Table 9. Data from these gages were reduced by NOS, and monthly tabulations of daily high and low waters and hourly heights are available at NOS (see Sec. VI). However, monthly mean values of the water level parameters defined below are presented in Figures 10 and 11 and Tables 10 and 11:

Table 3. Data availability for 1977.

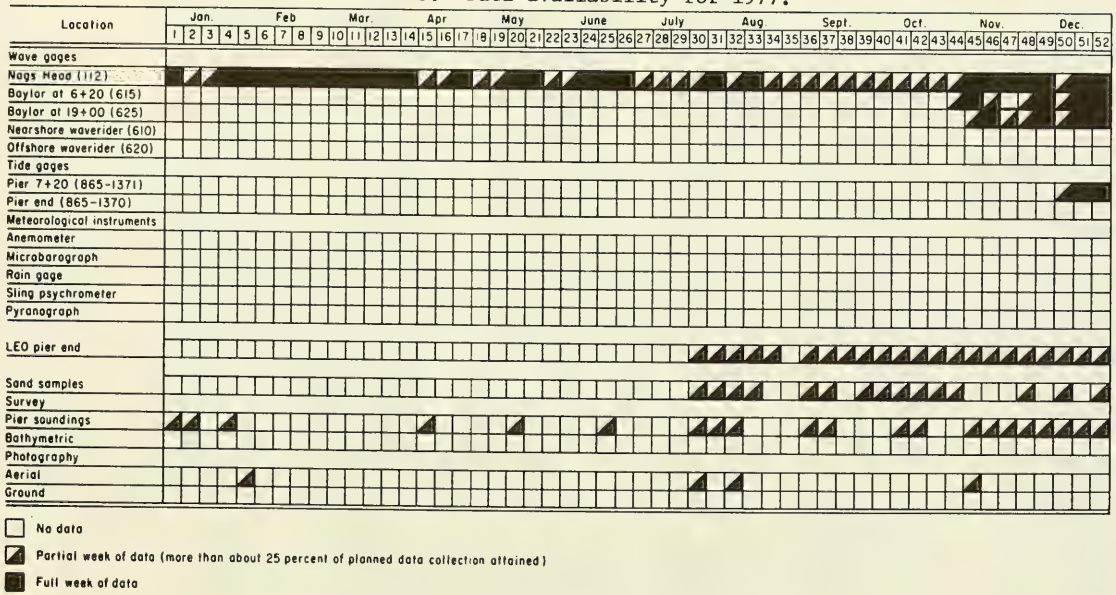


Table 4. Data availability for 1978.

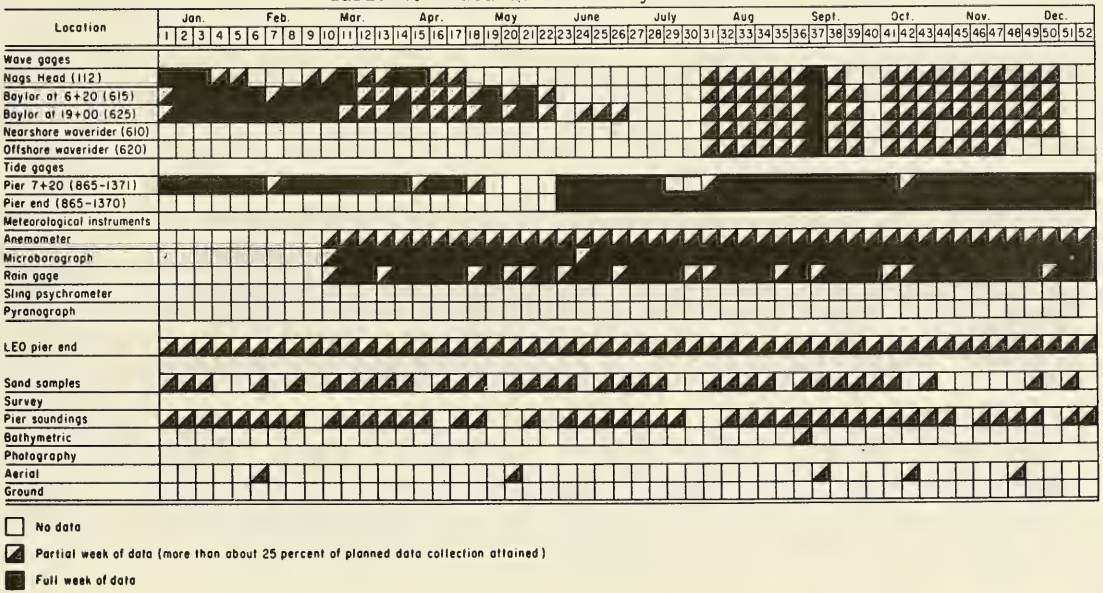
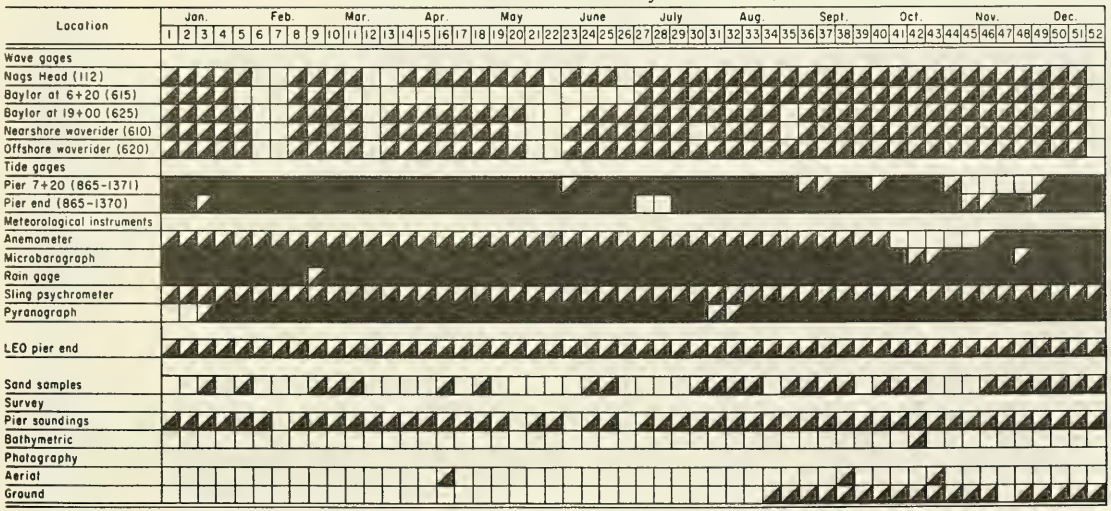


Table 5. Data availability for 1979.



No data

Partial week of data (more than about 25 percent of planned data collection attained)

Full week of data

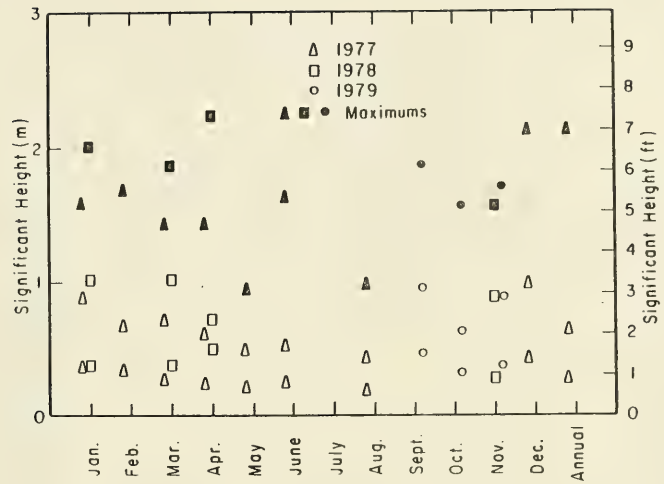


Figure 6. Wave height statistics for Nags Head, North Carolina, 1977-79 (CERC gage 112).

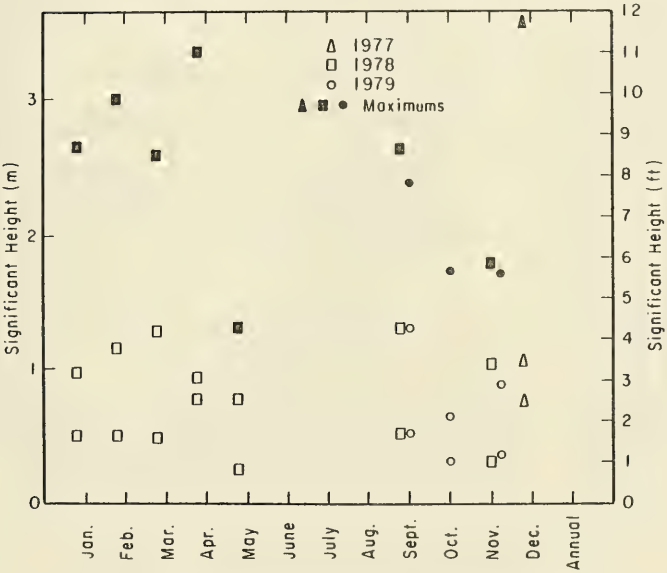


Figure 7. Wave height statistics at the FRF pier end, 1977-79 (Baylor gage at station 19+00, CERC gage 625).

Table 6. Joint distribution of significant wave height versus peak period at Nags Head, North Carolina, during 1977.

850 OBSERVATIONS SUMMARY FOR JAN 77 DEC 77

PERIOD (SECS)	SIG. HEIGHT (FT)											
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	TOT.*	CUM. TOT.*	ROW AVG.*
0.0 - .9											1000	0.00
1.0 - 1.9											1000	0.00
2.0 - 2.9		5								5	1000	1.50
3.0 - 3.9		8	5	2	2					18	995	2.43
4.0 - 4.9		13	18	18						48	978	2.60
5.0 - 5.9		15	34	15	5	1				71	929	2.68
6.0 - 6.9	5	20	31	26	18		1			100	859	2.86
7.0 - 7.9	8	39	20	13	12					92	759	2.29
8.0 - 8.9	39	162	61	19	15	5				301	667	1.91
9.0 - 9.9	7	62	20	9	5					104	366	1.94
10.0 -10.9	7	31	21	5	2	1	1			68	262	2.10
11.0 -11.9											194	0.00
12.0 -12.9	15	40	9	5		2	1			73	194	1.76
13.0 -13.9											121	0.00
14.0 -14.9	6	66	7	4		1		1		85	121	1.74
15.0 -15.9											36	0.00
16.0 -16.9		13	13	2		1	5			34	36	2.84
17.0 -17.9											2	0.00
18.0 -18.9											2	0.00
19.0 -19.9											2	0.00
20.0 -20.9		2								2	2	1.50
21.0 +												0.00
TOTAL	87	476	239	118	59	12	8	1				2.16
CUM. TOTAL	1000	913	436	198	80	21	9	1				
COL. AVG.	9.65	9.69	8.37	7.52	7.42	10.60	13.04	14.50				

AVERAGE SIG. HEIGHT = 2.13 FT
VARIANCE OF SIG. HEIGHT = 1.25 FT SQ
STANDARD DEVIATION OF HEIGHT = 1.12 FT

AVERAGE WAVE PERIOD = 9.02 SEC*
VARIANCE OF WAVE PERIOD = 9.07 SEC SQ
STANDARD DEVIATION OF PERIOD = 3.01 SEC

Table 7. Joint distribution of significant wave height versus peak period at FRF nearshore Baylor gage (615) during 1978.

528 OBSERVATIONS SUMMARY FOR JAN 78 THROUGH** DEC 78

PERIOD (SECS)	SIG. HEIGHT (FT) 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOT.*	CUM. TOT.*	RUN AVG.*
0.0 - .9																1000	0.00
1.0 - 1.9																1000	0.00
2.0 - 2.9		8	4												11	1000	1.83
3.0 - 3.9		15	11												27	989	1.93
4.0 - 4.9	4	44	40	4											91	962	1.98
5.0 - 5.9	9	74	112	49	6										250	871	2.37
6.0 - 6.9	4	15	28	21	11										80	621	2.76
7.0 - 7.9	4	2	8	11	4	2									30	542	3.00
8.0 - 8.9	15	47	28	34	17		2								144	511	2.49
9.0 - 9.9	8	47	23	19	4	2									102	367	2.20
10.0 -10.9	13	25	25	8		6	4								80	265	2.36
11.0 -11.9																186	0.00
12.0 -12.9	2	36	17	13	13	4	2								87	186	2.72
13.0 -13.9																98	0.00
14.0 -14.9	19	17	19	21	2										78	98	2.11
15.0 -15.9																21	0.00
16.0 -16.9	6	8	2	2											17	21	1.50
17.0 -17.9																4	0.00
18.0 -18.9																4	0.00
19.0 -19.9																4	0.00
20.0 -20.9	2	2													4	4	1.00
21.0 +																	0.00
TOTAL	85	339	316	182	57	13	8										2.36
CUM. TOTAL	1000	915	576	259	78	21	8										
COL. AVG.	10.48*	8.14	7.33	8.56	8.93	10.50	10.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.25		

Table 8. Joint distribution of significant wave height versus peak period at FRF pier-end Baylor gage (625) during 1978.

590 OBSERVATIONS SUMMARY FOR JAN 78 THROUGH** DEC 78

PERIOD (SECS)	SIG. HEIGHT (FT)															CUM.	ROW
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOT.*	TOT.*	AVG.*
0.0 - .9																1000	0.00
1.0 - 1.9																1000	0.00
2.0 - 2.9	2	3													5	1000	1.17
3.0 - 3.9		3	14												17	995	2.30
4.0 - 4.9		3	15	15	2	2									37	978	3.05
5.0 - 5.9		25	44	47	20	7	5	2							151	941	3.24
6.0 - 6.9	2	24	17	14	8	17	10	2	3						96	790	3.78
7.0 - 7.9		14	5	2	8	7		3	2	2					42	694	4.02
8.0 - 8.9		58	51	32	17	17	7	3	3						188	651	3.16
9.0 - 9.9		47	49	17	24	3	10	3			3				157	464	3.21
10.0 -10.9		32	37	24	22	3	2	2			3				125	306	3.20
11.0 -11.9																181	0.00
12.0 -12.9		19	36	17	15	3	5	3	2	3	2				105	181	3.68
13.0 -13.9																76	0.00
14.0 -14.9		17	8	15	24	3		2							69	76	3.43
15.0 -15.9																7	0.00
16.0 -16.9	3	3	2												7	7	1.50
TOTAL	5	249	277	183	140	63	39	20	10	5	8						3.31
CUM. TOTAL	1000	995	746	469	286	146	83	44	24	14	8						
COL. AVG.	8.50*	9.01	8.61	8.45	9.77	8.12	8.46	9.42	8.33	10.83	10.50	0.00	0.00	0.00	8.85		

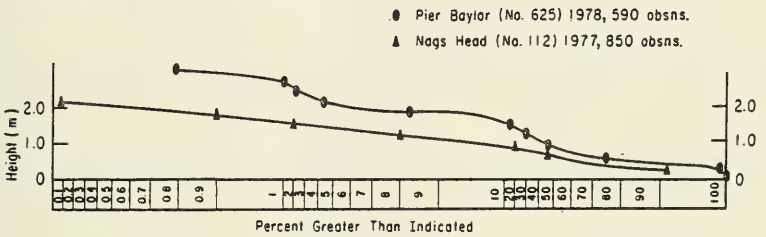


Figure 8. Annual cumulative significant wave height distributions at Nags Head and the FRF pier-end Baylor gages.

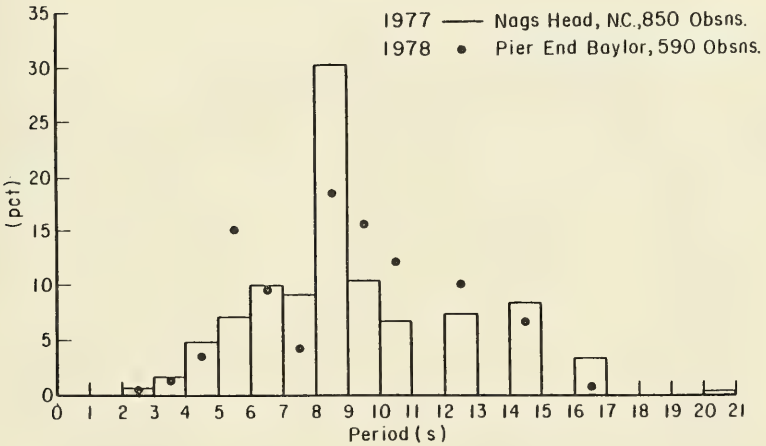


Figure 9. Peak period distributions at Nags Head and the FRF pier-end Baylor gages.

Table 9. FRF tide gage histories.

Location	Water depth, MSL (m)	Type of gage	Proper operation Beginning	Proper operation End	Explanation
FRF pier sta. 19+60 (NOS gage 865-1370)	8	Digital recording float type (Leupold Stevens; Fischer-Porter)	June 1978	10 Nov. 1979	Battery problem.
			13 Nov. 1979	2 July 1979	Gage stopped, possible orifice problem.
			13 July 1979	Present	
FRF pier sta. 7+20 (NOS gage 865-1371)	3	Digital recording float type (Leupold Stevens; Fischer-Porter)	19 Jan. 1978	8 Apr. 1978	Orifice closed due to biological fouling.
			11 Apr. 1978	1 May 1978	Orifice silted in.
			2 June 1978	15 June 1978	Problem unknown.
			31 June 1978	16 Oct. 1978	Orifice silted in.
			18 Oct. 1979	5 June 1979	Problem unknown.
			7 June 1979	5 Sept. 1979	Orifice silted in.
			10 Sept. 1979	1 Oct. 1979	Battery problem.
			2 Oct. 1979	1 Nov. 1979	Orifice silted in.
			3 Dec. 1979		

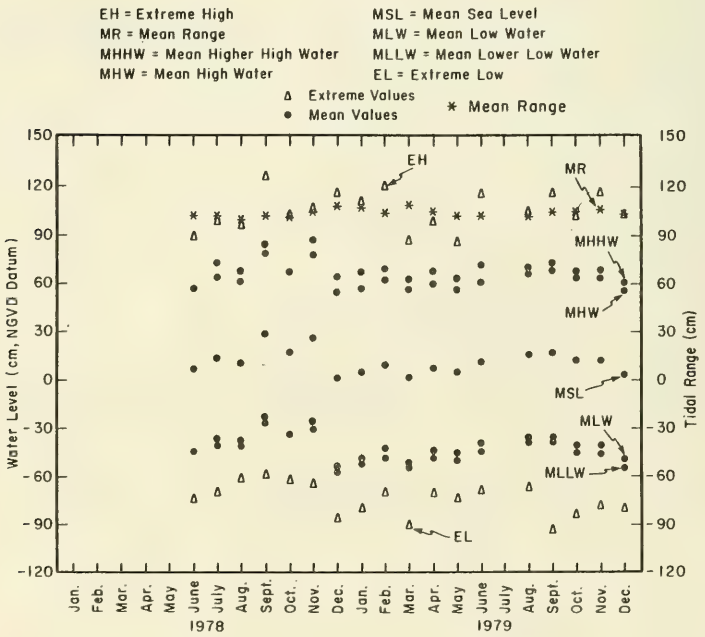


Figure 10. Tide-water level statistics for the pier-end tide stations 865-1370.

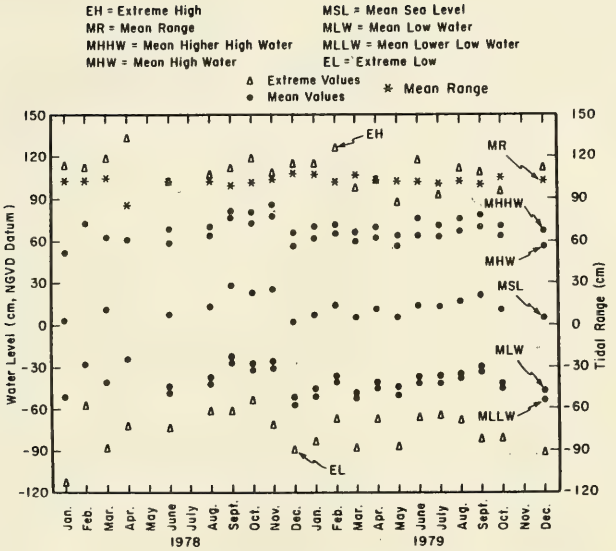


Figure 11. Tide-water level statistics for the nearshore tide stations 865-1371.

Table 10. Tide statistics for the pier-end NOS primary tide station 865-1370 at pier-end station 19+60.

Year and month	MHHW (cm)	MHW (cm)	MTL (cm)	MSL (cm)	MLW (cm)	MLLW (cm)	MR (cm)	EH (cm)	EH Date occurred	EL (cm)	EL Date occurred
1978 June		56.4	5.8	6.1	-44.8		101.2	89.0	22	-74.1	22
July	72.5	63.4	13.1	13.7	-37.2	-42.1	100.6	98.6	17	-70.4	22
Aug.	67.4	60.4	11.0	10.7	-38.4	-42.1	98.8	96.3	18	-61.6	8 and 9
Sept.	84.1	78.6	28.0	28.3	-22.6	-27.1	101.2	126.8	13	-59.4	17
Oct.		67.1	16.8	17.1	-33.5		100.6	104.5	2	-62.8	11
Nov.	85.6	76.8	25.3	25.9	-25.9	-30.5	102.7	106.7	4	-65.2	30
Dec.	64.0	53.6	.0	0.3	-53.6	-58.2	107.2	116.1	1	-86.0	26
Avg.	74.7	65.2	14.3	14.6	-36.6	-39.9	101.8	126.8	Sept.	-86.0	Dec.
1979 Jan.	65.5	57.3	2.4	4.6	-49.1	-53.3	106.4	110.0	27	-81.4	4
Feb.	68.0	60.4	8.8	9.4	-42.7	-48.8	103.1	120.7	26	-70.1	28
Mar.	61.9	55.2	1.5	1.8	-52.1	-55.2	107.3	86.0	26	-91.1	28
Apr.	66.4	59.1	7.0	7.3	-44.8	-49.1	103.9	97.5	14	-72.5	24
May	62.8	54.6	4.0	4.3	-46.3	-50.3	100.9	85.3	19	-74.4	25
June	70.7	60.7	10.1	10.7	-40.2	-44.5	100.9	115.2	11	-68.9	16
Aug.	73.8	64.9	14.6	14.9	-36.0	-39.0	100.9	104.9	7	-67.4	11
Sept.	76.5	68.3	15.8	16.5	-36.0	-39.0	104.0	115.2	23	-95.1	6
Oct.	71.6	63.4	11.6	11.6	-40.5	-45.1	103.9	103.6	24	-84.7	7
Nov.	72.5	63.4	11.0	11.6	-41.1	-46.3	104.5	116.1	4	-78.3	18
Dec.	65.2	54.6	2.7	3.0	-48.8	-54.3	103.4	102.1	21	-80.5	4
Avg.	68.9	60.0	8.5	9.1	-43.0	-43.6	103.0	120.7	26 Feb.	-95.1	Sept.

Table 11. Tide statistics for the nearshore tide gage 865-1371 at pier station 7+20.

Year and month	MHHW (cm)	MHW (cm)	MTL (cm)	MSL (cm)	MLW (cm)	MLLW (cm)	MR (cm)	EH (cm)	EH Date occurred	EL (cm)	EL Date occurred
1978 Jan.		51.2	0.3	0.3	-50.6		101.8	113.4	8	-113.1	10
Feb.		73.2	21.9		-29.3		102.5	111.9	6	-58.8	24
Mar.		63.2	10.7	11.0	-40.5		103.7	117.3	10	-88.7	8
Apr.		60.4	17.7		-25.0		85.4	134.4	26	-72.2	1
June	67.4	57.6	6.7	7.3	-44.2	-49.4	101.8	90.5	22	-74.4	22
Aug.	69.5	63.1	12.5	12.8	-38.4	-41.8	101.5	106.7	21	-61.2	8
Sept.	81.4	75.9	26.5	27.1	-22.6	-27.7	98.5	110.9	13	-61.6	17
Oct.	79.6	72.2	22.3	22.6	-28.0	-32.3	100.2	118.3	15	-54.9	11
Nov.	85.0	75.9	24.4	25.0	-26.8	-31.4	102.7	109.1	4	-71.9	30
Dec.	65.2	54.6	1.5	1.5	-51.8	-57.9	106.4	114.3	1	-89.9	26
Avg.	74.7	64.6	14.3	13.4	-35.7	-40.2	100.3	118.3	15 Oct.	-89.9	26 Dec.
1979 Jan.	68.6	60.0	6.7	6.7	-46.3	-51.5	106.3	114.0	27	-83.5	4
Feb.	70.7	64.0	13.7	13.4	-36.9	-41.1	100.9	126.2	26	-67.4	28
Mar.	64.6	57.6	4.6	4.6	-48.8	-52.4	106.4	87.2	3	-89.3	28
Apr.	68.9	61.9	10.1	10.1	-41.8	-46.0	103.7	102.7	14	-67.7	11
May	63.4	55.2	4.9	5.2	-45.4	-50.3	100.9	86.3	17	-89.3	25
June	73.5	63.1		13.1	-37.8	-41.5	100.9	117.3	11	-66.8	16
July	69.8	61.9	11.9	12.5	-37.8	-42.1	99.7	92.0	11	-65.8	10
Aug.	75.0	65.8	14.9	15.2	-35.7	-38.7	101.5	110.9	21	-69.2	11
Sept.	76.8	68.9	19.2	20.1	-30.2	-33.8	99.1	109.1	9	-83.2	6
Oct.	70.4	62.5	10.7	10.7	-41.5	-45.7	104.0	95.7	5	-85.0	7
Dec.	65.8	55.2	3.7	4.3	-47.5	-53.9	102.7	111.3	21	-91.7	29
Avg.	69.8	61.6	10.1	10.7	-40.8	-45.1	102.4	126.2	26 Feb.	-91.7	23 Dec.

(a) Mean high water (MHW) - the average of all high water levels;

(b) Mean low water (MLW) - the average of all low water levels;

(c) Mean sea level (MSL) - the average of hourly tidal heights;

(d) Mean range (MR) - the difference between MHW and MLW;

(e) Mean tide level (MTL) - MHW plus MLW divided by 2;

(f) Mean higher high water (MHHW) - the average of the highest high water levels; and

(g) Mean lower low water (MLLW) - the average of the lowest low water levels.

4. Meteorological Data.

The meteorological data are based on daily (excluding weekends and holidays) observations made about 0700 e.s.t., coincident with the daily sensor maintenance and LEO observations. Appendix B contains monthly summaries of the daily weather observations, along with a chart record availability table. Tables 12 and 13 are annual meteorological data summaries for 1978 and 1979.

Table 12. Annual meteorological data summary for 1978.

Month	Temperature					Precipitation	No. of obsns.	Wind (m/s)								
	Avg.	EH		EL				Speed (avg.)	Resultant					Extreme		
									Direction (° true N.)			Speed			Direction (° true N.)	Speed	Date occurred
		(°C)	Date occurred	(°C)	Date occurred											
						(mm)			Va.[1]	FRF[2]	N.C.[3]	Va.[1]	FRF[2]	N.C.[3]			
Mar.	8.3	22.2	17 30	-5.0	2	137	22	4.3	10	23	360	1.4	1.0	0.8	180 50	7.7	14 30
Apr.	13.3	26.1	12	5.0	24	76	19	5.1	50	9	280	0.4	0.8	0.6	50	15.4	26
May	16.7	29.4	22	7.8	2	145	22	3.4	120	30	190	1.0	0.7	0.4	50	6.1	2
June	22.2	31.7	29	14.4	5	130	22	3.8	180	237	200	1.0	1.8	0.9	20 230	6.1	14 20
July	24.4	33.9	11 24	17.8	13	104	20	3.1	180	43	230	0.5	0.7	1.4	50	7.2	12
Aug.	25.6	33.9	18 30	18.9	24	36	22	3.0	200	221	210	1.4	1.4	2.2	230	5.1	25
Sept.	22.8	33.9	20	15.6	25	13	21	3.5	50	23	40	1.5	1.9	2.6	20 50	6.7	20 26
Oct.	15.6	25.6	27	3.9	16	25	21	3.8	20	10	20	1.0	1.6	2.8	20	8.7	24
Nov.	13.9	23.9	19	3.9	26	130	20	3.8	40	40	30	1.7	1.4	2.7	150	6.2	27
Dec.	8.3	24.4	10	-1.1	28	84	20	4.5	290	358	310	1.5	1.3	1.9	20 30 30	7.7	12 28 31
Annual	17.2	33.9		-5.0		879	209	3.8	360	8	350	0.4	0.7	0.8		15.4	

[1] Norfolk, Virginia.

[2] FRF pier, Duck, North Carolina.

[3] Cape Hatteras, North Carolina.

Table 13. Annual meteorological data summary for 1979.

Month	Temperature					Precipitation	No. of obsns.	Wind (m/s)								
	Avg.	EH		EL				Speed (avg.)	Resultant						Extreme		
		(°C)	Date occurred	(°C)	Date occurred				Direction (° true N.)			Speed			Direction (° true N.)	Speed	Date occurred
						(mm)			Va.[1]	FRF[2]	N.C.[3]	Va.[1]	FRF[2]	N.C.[3]			
Jan.	4.4	19.4	3 25	-5.6	4 16	180	22	4.7	300	284	230	2.1	2.0	2.3	260	7.7	29
Feb.	1.1	18.9	25	-7.8	10	94	15	4.6	10	9	350	2.4	1.1	2.2	100	11.3	7
Mar.	8.3	23.9	31	-0.6	16	64	21	4.0	230	352	310	0.8	1.0	0.7	360	7.7	15
Apr.	13.9	25.6	2 3	5.0	18	71	21	4.5	260	239	220	0.2	1.1	0.8	200	9.3	9
May	17.8	27.8	14 24	10.6	1	239	21	4.2	190	199	200	1.2	0.7	1.4	40	8.2	17
June	20.6	31.7	24	13.9	13	71	21	4.9	150	29	50	0.6	1.8	1.6	20 50	8.7	25 27
July	25.6	43.3	5	12.8	9	69	20	3.5	270	329	240	0.7	0.4	1.1	50	5.7	16
Aug.	23.9	36.1	11	16.1	18	48	23	3.6	220	269	210	0.4	1.0	1.3	360	7.2	16
Sept.	22.2	31.1	4 7	14.4	19	160	20	4.9	90	45	80	1.8	2.2	1.4	180	8.7	14
Oct.	15.0	28.3	3	4.4	27 28	56	22	4.4	260	241	310	1.0	1.6	1.4	280	8.2	25
Nov.	12.2	24.4	3 27	-2.2	19	97	18	3.2	300	18	360	0.4	0.6	0.6	90 50 320	7.2	1 5 14
Dec.	6.1	19.4	13 14	-3.3	18	48	20	4.2	320	256	340	1.2	1.4	2.4	340	10.3	17
Annual	14.4	43.3		-7.8		1196	244	4.2	300	255	310	0.3	0.6	0.5	100	11.3	

[1] Norfolk, Virginia.

[2] FRF pier, Duck, North Carolina.

[3] Cape Hatteras, North Carolina.

The resultant wind speed and direction values for Norfolk, Virginia, and Cape Hatteras, North Carolina, obtained from the NOAA, NWS Local Climatological Data Summaries, are included beside the FRF value, respectively, for comparison. As expected, the values for these two locations are somewhat different than the values at the FRF since they are based on data records that were taken hourly 7 days a week, rather than the one-time daily readings obtained at the FRF.

5. Visual Observations.

Monthly and annual summaries of visually obtained wave data, wind roses, and annual longshore current graphs are presented based on the data for 1977-79 in Tables 14, 15, and 16; visual observations were obtained using LEO program

Table 14. LEO data summary, 27 July to 30 December 1977.

Month	Wave height (cm)			Wave period (s)			Direction						Current (cm/s)			
							Pct. occ.									
	Mean	Std. dev.	No. of obsns.	Mean	Std. dev.	No. of obsns.	>90	=90	<90	Mean	Std. dev.	No. of obsns.	Net mean	Gross mean	Std. dev.	No. of obsns.
July	100	23	6	6.35	2.13	6	0.00	50.00	50.00	85.83	4.92	6				
Aug.	31	12	22	9.16	2.57	21	90.48	9.52	0.00	107.86	13.00	21	-7	15	10	17
Sept.	84	39	16	7.89	1.88	15	40.00	6.67	53.33	86.00	21.81	15	5	23	15	16
Oct.	128	102	16	8.03	1.79	15	35.71	14.29	50.00	87.86	23.51	14	14	27	25	14
Nov.	103	89	16	9.10	1.17	14	57.14	14.29	28.57	94.29	18.38	14	4	18	12	15
Dec.	96	106	21	10.15	2.32	21	52.38	19.05	28.57	98.10	22.05	21	17	33	36	19
Overall	86	81	97	8.80	2.28	92	53.85	15.38	30.77	95.38	20.43	91	5	24	22	81

Table 15. LEO data summary, 3 January to 29 December 1978.

Month	Wave height (cm)			Wave period (s)			Direction						Current (cm/s)			
							Pct. occ.									
	Mean	Std. dev.	No. of obsns.	Mean	Std. dev.	No. of obsns.	>90	=90	<90	Mean	Std. dev.	No. of obsns.	Net mean	Gross mean	Std. dev.	No. of obsns.
Jan.	56	36	17	10.03	2.84	16	50.00	6.25	43.75	90.00	16.43	16	15	19	19	17
Feb.	80	48	16	10.36	2.85	15	13.33	26.67	60.00	85.53	6.60	15	37	37	23	18
Mar.	72	32	22	10.11	1.53	19	42.11	15.79	42.11	90.68	11.69	19	37	34	27	21
Apr.	103	101	16	8.59	1.69	15	53.33	26.67	20.00	99.33	17.71	15	15	36	30	15
May	51	21	17	8.79	1.51	13	76.92	0.00	23.08	98.23	17.20	13	10	29	16	17
June	34	9	22	8.07	1.19	18	88.24	5.88	5.88	108.82	16.25	17	-1	22	18	22
July	53	24	18	8.35	1.72	14	57.14	14.29	28.57	91.21	11.63	14	4	23	14	19
Aug.	40	16	19	9.91	2.12	16	87.50	6.25	6.25	98.75	14.43	16	4	20	13	19
Sept.	64	30	20	9.64	1.52	20	45.00	35.00	20.00	91.50	7.80	20	12	27	14	19
Oct.	94	60	20	9.37	1.73	20	40.00	40.00	20.00	90.50	12.97	20	10	23	16	21
Nov.	70	22	20	8.45	1.56	19	44.44	22.22	33.33	90.56	12.82	18	9	15	12	18
Dec.	54	26	20	9.24	2.39	17	23.53	23.53	52.94	84.12	10.19	17	9	22	13	21
Overall	64	45	227	9.26	2.02	2.02	51.00	19.50	29.50	93.10	14.43	200	11	25	18	227

Table 16. LEO data summary, 2 January to 28 December 1979.

Month	Wave height (cm)			Wave period (s)			Direction						Current (cm/s)			
							Pct. occ.									
	Mean	Std. dev.	No. of obsns.	Mean	Std. dev.	No. of obsns.	>90	=90	<90	Mean	Std. dev.	No. of obsns.	Net mean	Gross mean	Std. dev.	No. of obsns.
Jan.	56	26	21	8.82	2.17	19	36.84	10.53	52.63	87.89	17.02	19	15	25	15	22
Feb.	78	34	15	8.67	1.96	15	53.33	0.00	46.67	87.00	15.33	15	22	29	22	15
Mar.	62	33	24	8.60	1.44	24	62.50	12.50	25.00	91.25	18.84	24	20	32	13	24
Apr.	51	22	20	9.70	2.32	19	31.58	21.05	47.37	86.32	20.74	19	10	23	9	21
May	46	31	21	9.54	1.38	18	77.78	0.00	22.22	96.39	22.67	18	13	36	20	21
June	75	25	17	8.33	1.29	17	76.47	5.88	17.65	93.82	11.53	17	21	30	19	17
July	27	15	20	8.06	2.12	17	58.82	11.76	29.41	97.18	18.72	17	6	27	24	20
Aug.	47	20	23	10.32	5.16	23	68.18	13.64	18.18	98.18	13.23	22	7	32	18	23
Sept.	87	34	19	7.97	2.02	19	57.89	0.00	42.11	97.11	18.28	19	14	26	20	19
Oct.	46	27	21	7.12	1.90	21	61.90	9.52	28.57	92.86	19.97	21	8	29	14	21
Nov.	74	39	19	8.45	2.63	19	63.16	10.53	26.32	93.16	20.49	19				
Dec.	67	52	30	6.41	2.59	28	40.00	10.00	50.00	80.50	35.17	30	7	30	19	30
Overall	59	35	250	8.44	2.71	239	56.67	9.17	34.17	91.36	21.40	240	12	27	18	252

procedures. The average monthly wind roses and the average annual wind rose, based on LEO data collected between 27 July 1977 and 28 December 1979, are presented in Figure 12. These data were taken from values obtained using a Dwyer wind meter at the seaward end of the FRF pier. Figures 13, 14, and 15 are graphs of the longshore current magnitude, direction, and monthly mean versus time for the pier-end LEO site.

A wave rose for the overall reporting period (1977-79), based on the single visually observed estimates of wave height and direction of wave approach at the seaward end of the FRF pier, is presented in Figure 16. Figures 17 and 18 show the annual wave roses for 1978 and 1979, respectively; Figures 19 and 20 are summer (April to September) and winter (October to March) wave roses for 1979. Although the estimated wave height appears to agree reasonably well with the instrument data obtained at the same time, it should be noted that these conditions do not reflect daily averages; the LEO data are daily instantaneous values indicative of the conditions at about 0700 e.s.t.

6. Sediment Data.

At least monthly and often weekly sand samples were taken from the foreshore at a beach site approximately 150 meters north of the FRF pier. Figure 21 shows the mean sediment diameter versus week of the year. The data for April 1978 through the end of 1979 represent the visually estimated size of the predominant sand grain size in the sample and seem to show an observer bias when compared with the settling tube data from the CERC Rapid Sediment Analyzer (RSA). The results of a more detailed sediment survey performed in August 1979 are presented in Appendix C.

7. Survey Data.

A bathymetric survey was performed in October 1979. Figure 22 is a contour diagram of the resultant bathymetry, and Table 1 (see Sec. IV) lists the ranges surveyed, their distances from the pier, and the extent of the ranges offshore. Figure 23 shows the locations of the survey ranges in the vicinity of the FRF. Figures 24 and 25 show the comparisons of the northern and southern ranges, respectively, for the overlapping parts of the beach profiles from surveys during 1978 and 1979.

Weekly pier surveys from both sides of the pier were performed; Appendix D contains monthly overlay profile plots for the data. Annual and overall envelopes of the profiles for all the surveys are shown in Figures 26 and 27. Figure 28 shows the time history of the bottom elevations for the pier-end Baylor, nearshore Baylor, pier-end and nearshore tide gage locations, and a number of the other survey stations along the pier.

8. Photographic Data.

Quarterly aerial photography missions were flown as part of the measurement program. The data are stored in film canisters as continuous rolls of 9- by 9-inch photographic negatives (see Fig. 29 for photo sample). Table 2, which is in Section IV, itemizes the photographic missions. Daily ground photos of the beach looking north and south from the FRF pier were obtained, starting in August 1979. Figures 30 and 31 present samples for the north and south beaches, respectively.

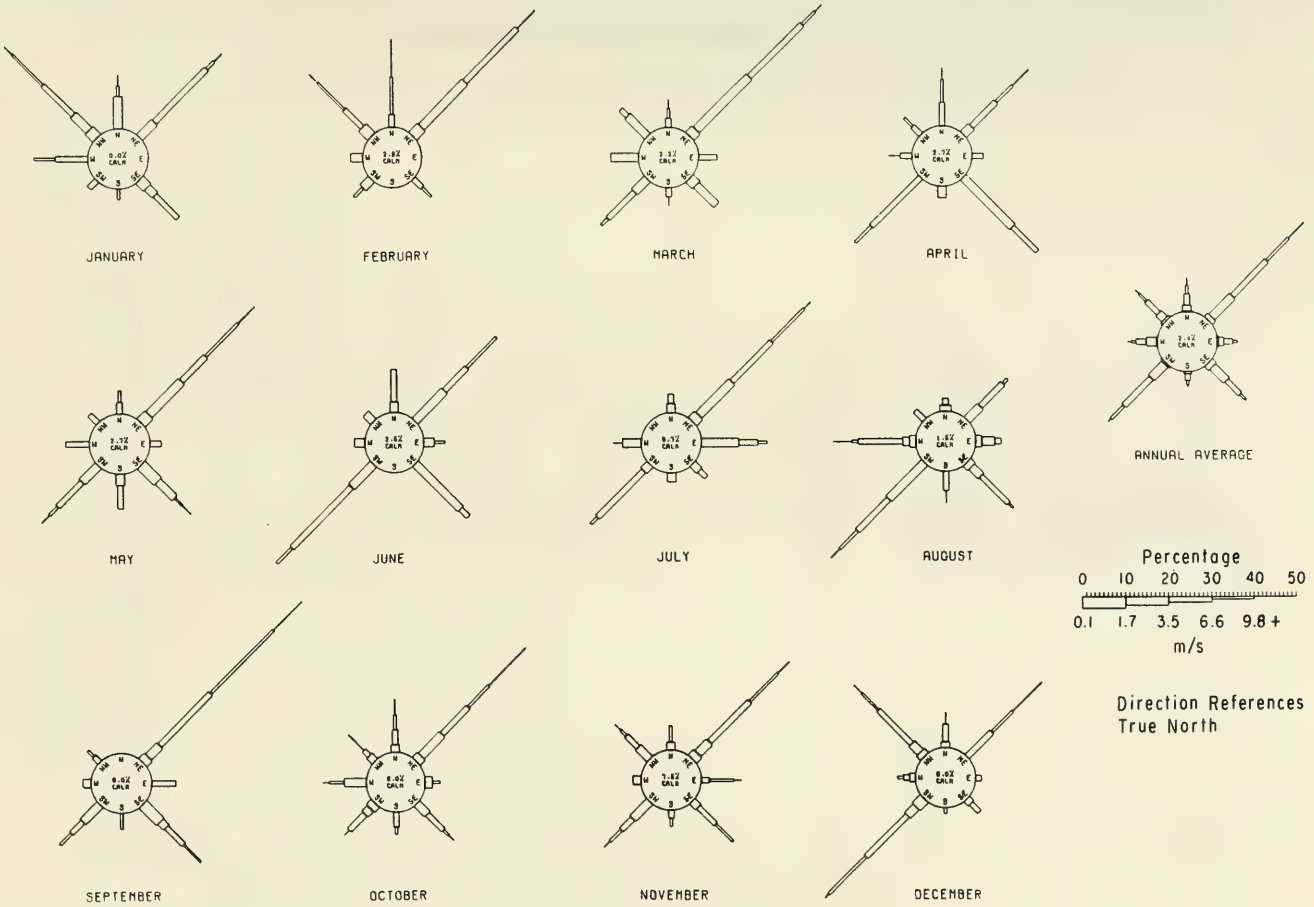


Figure 12. Wind roses for pier-end LEO site, based on observations from 27 July 1977 to 28 December 1979.

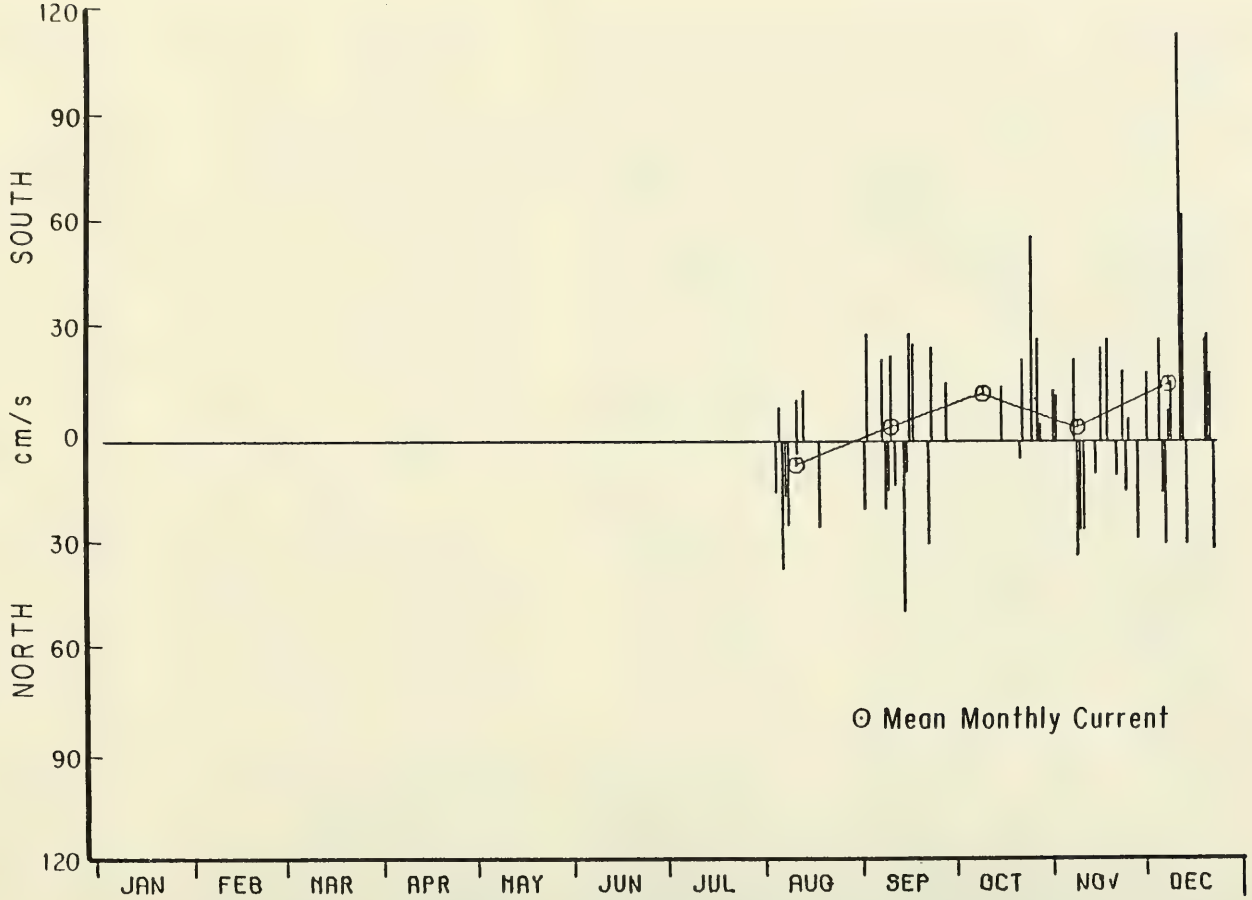


Figure 13. Longshore currents at the seaward end of the FRF pier, 1977.

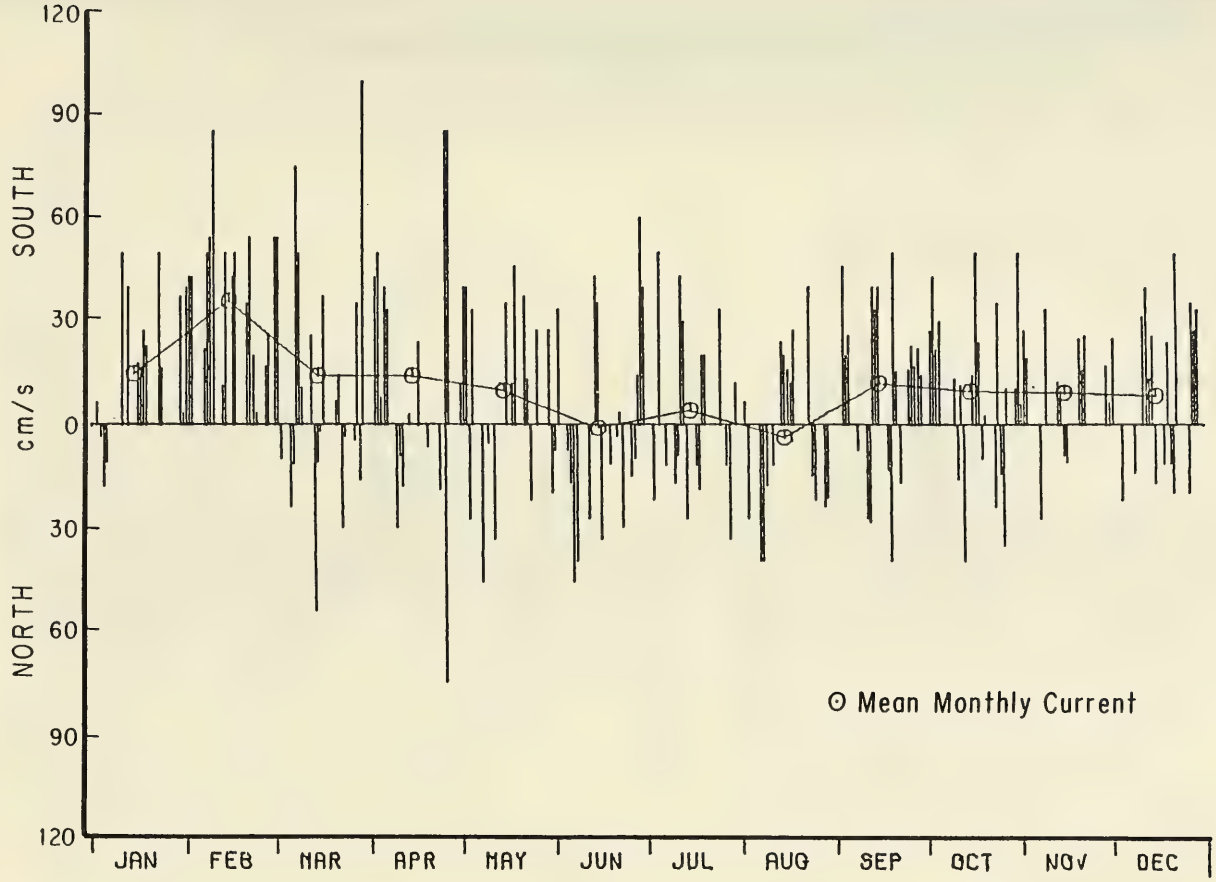


Figure 14. Longshore currents at the seaward end of the FRF pier, 1978.

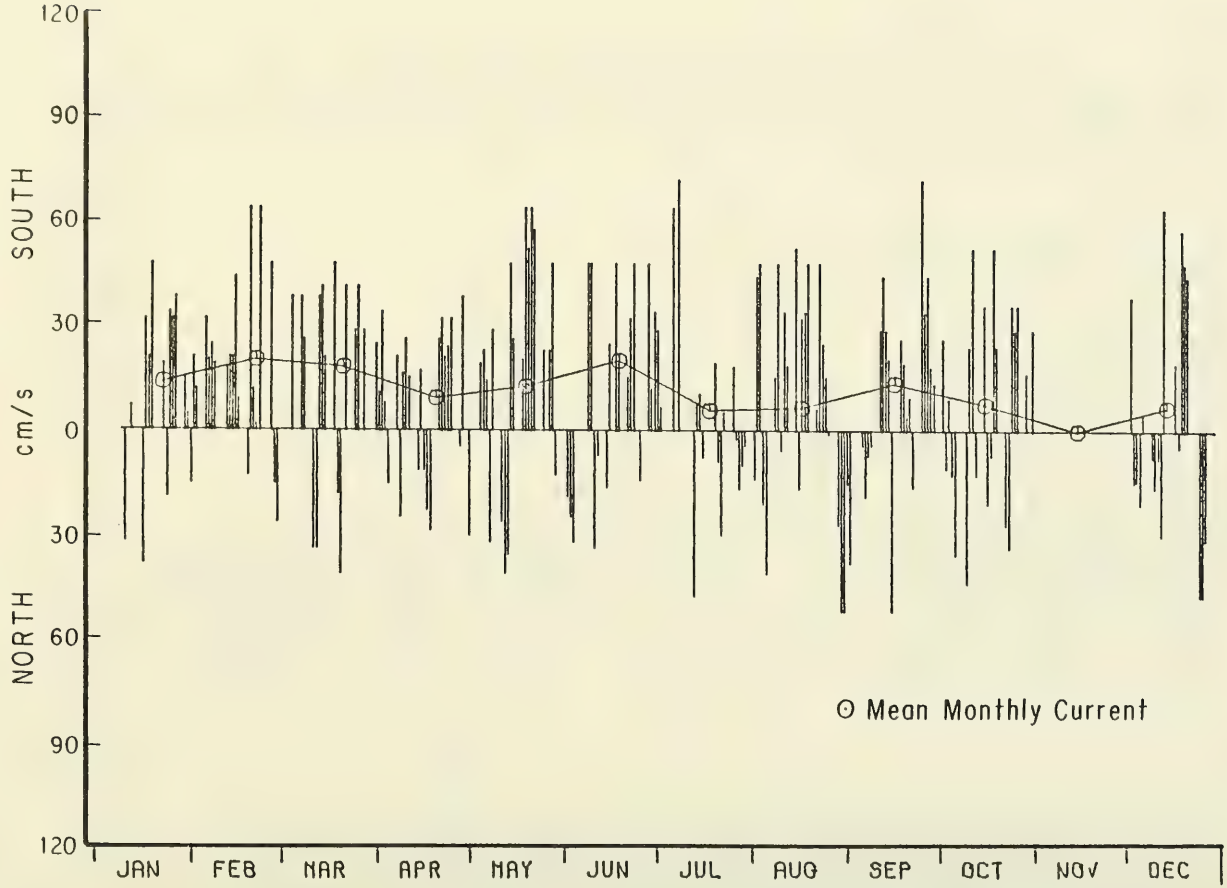


Figure 15. Longshore currents at the seaward end of the FRF pier, 1979.

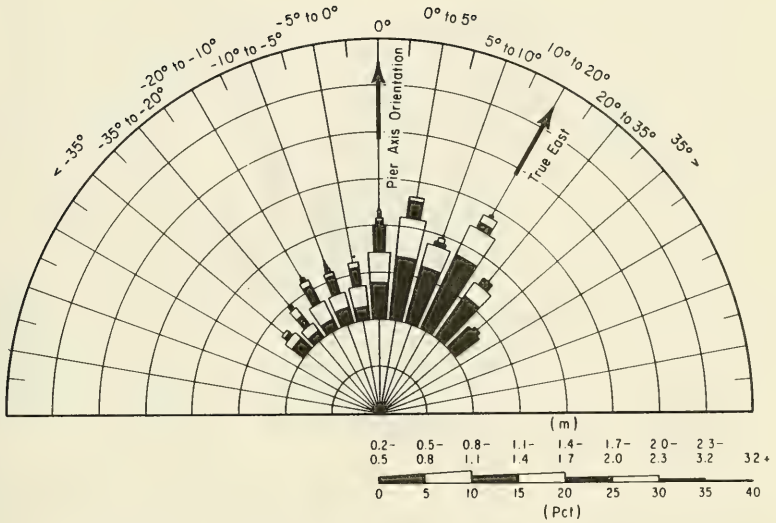


Figure 16. Wave rose based on 1977-79 LEO data at the seaward end of the FRF pier.

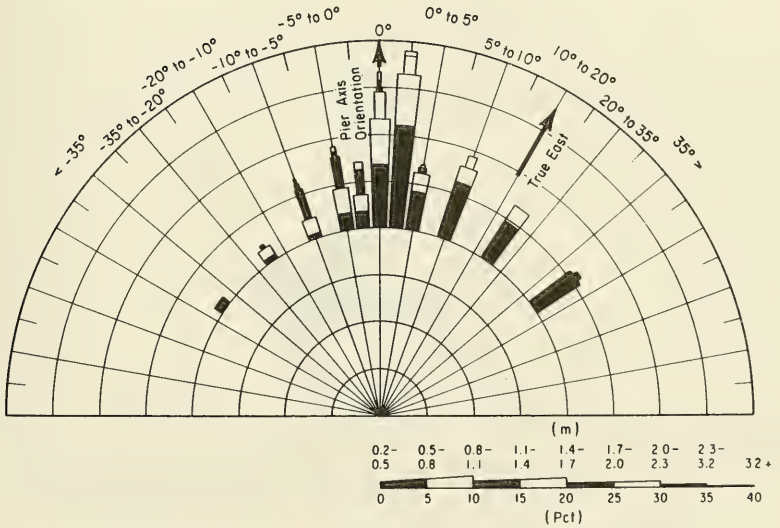


Figure 17. Wave rose based on 1978 LEO data at the seaward end of the FRF pier.

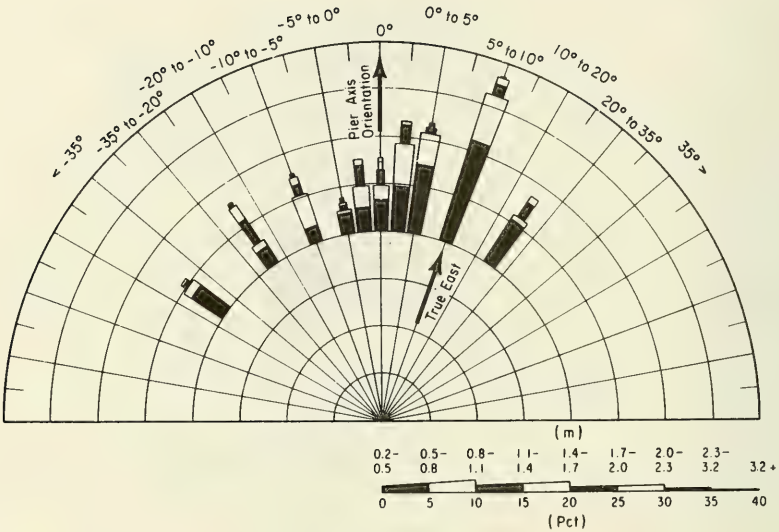


Figure 18. Wave rose based on 1979 LEO data at the seaward end of the FRF pier.

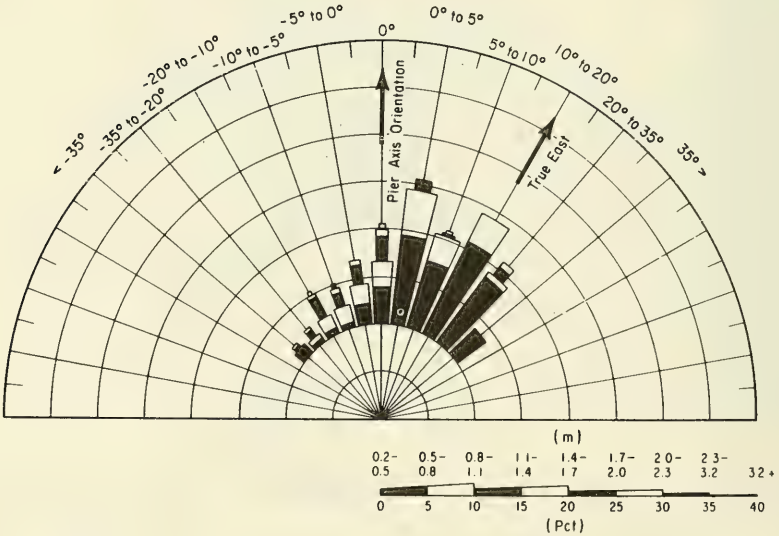


Figure 19. Wave rose based on April-September 1979 LEO data at the seaward end of the FRF pier.

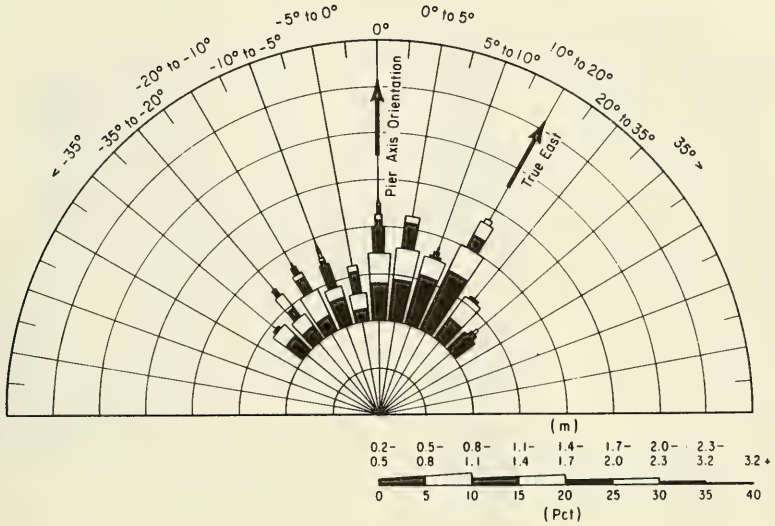


Figure 20. Wave rose based on January-March and October-December 1979 LEO data at the seaward end of the FRF pier.

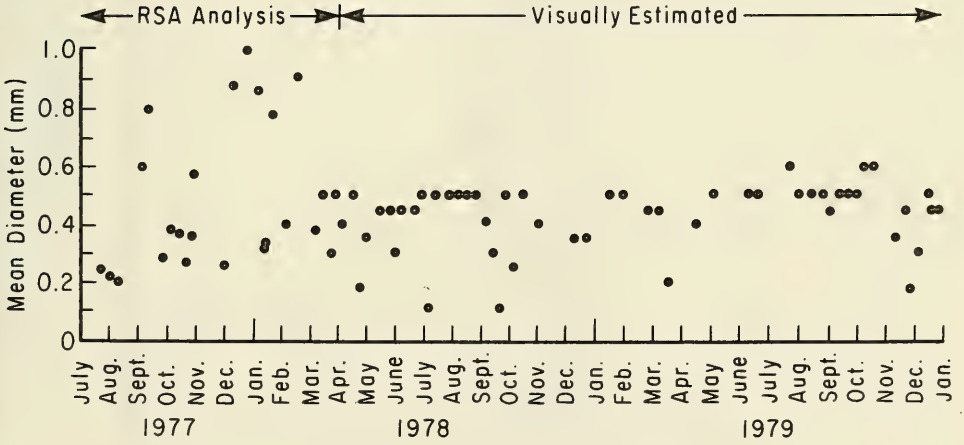


Figure 21. Mean foreshore sand size versus time from the beach 150 meters north of the FRF pier.

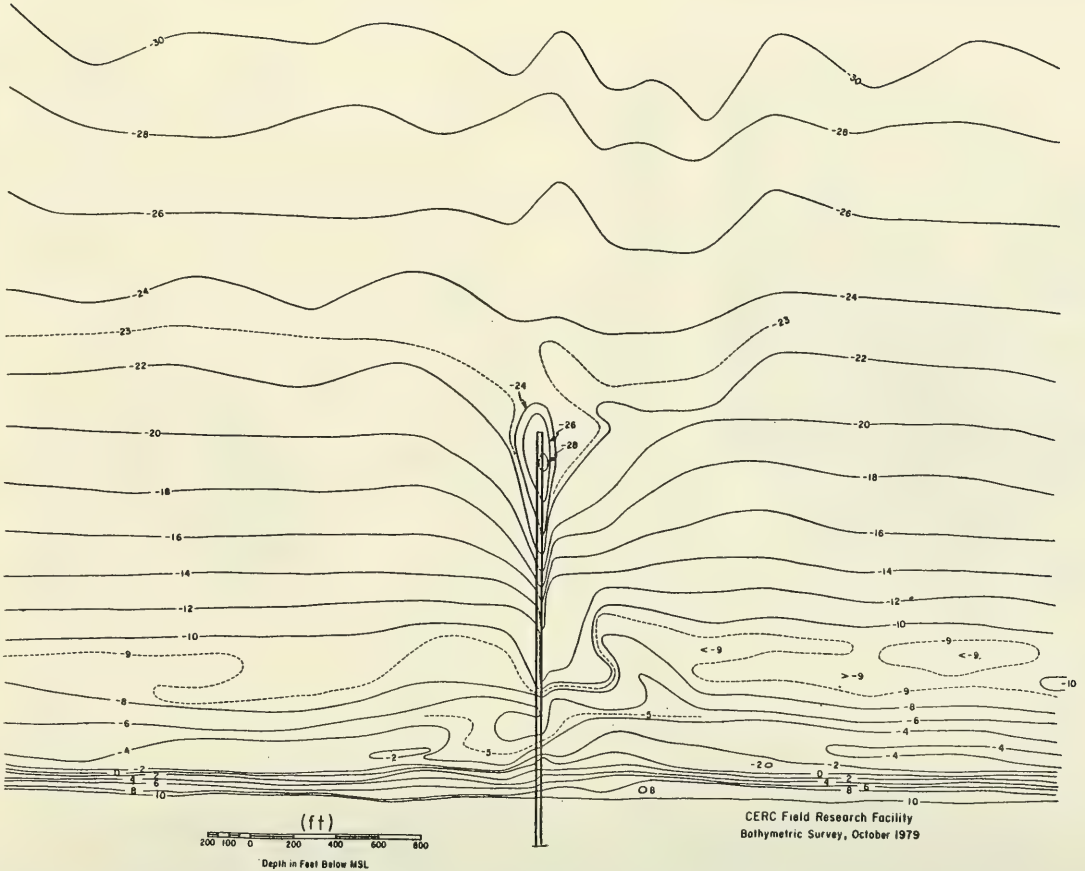


Figure 22. Contour diagram of bathymetry near the FRF pier, October 1979.

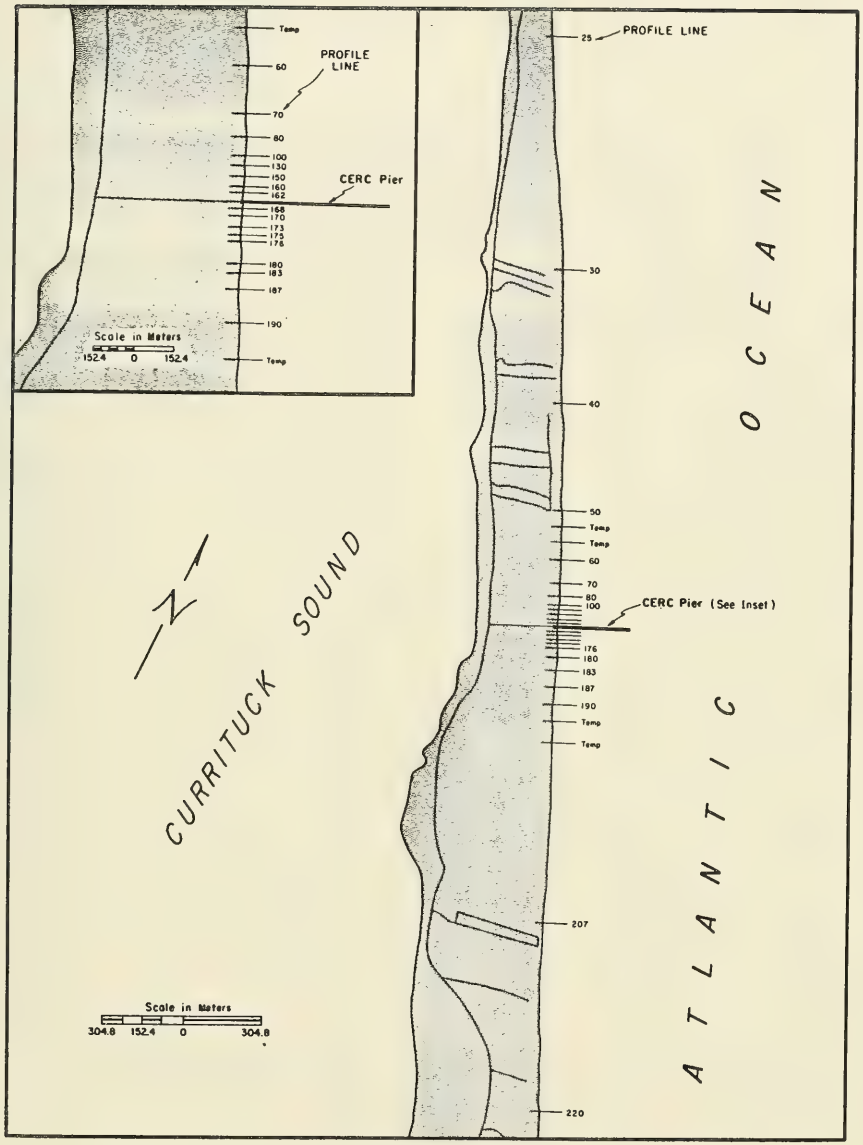


Figure 23. Survey ranges in the vicinity of the FRF.

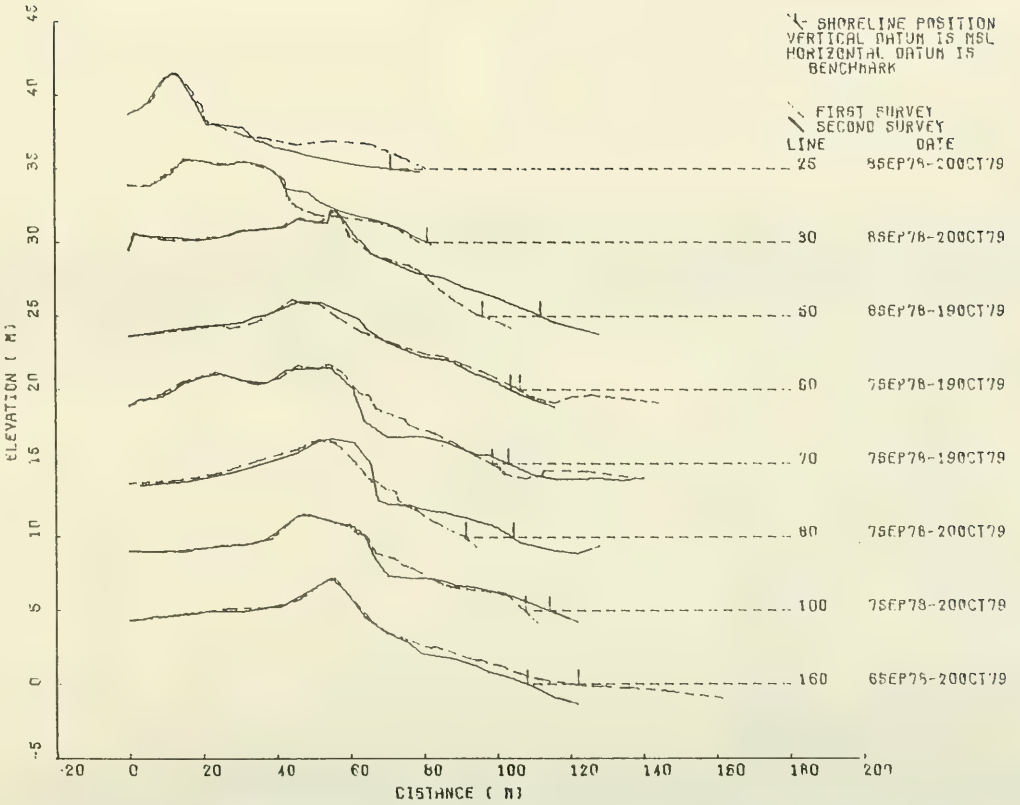


Figure 24. Comparison of beach profiles for the northern range, 1978-79 surveys.

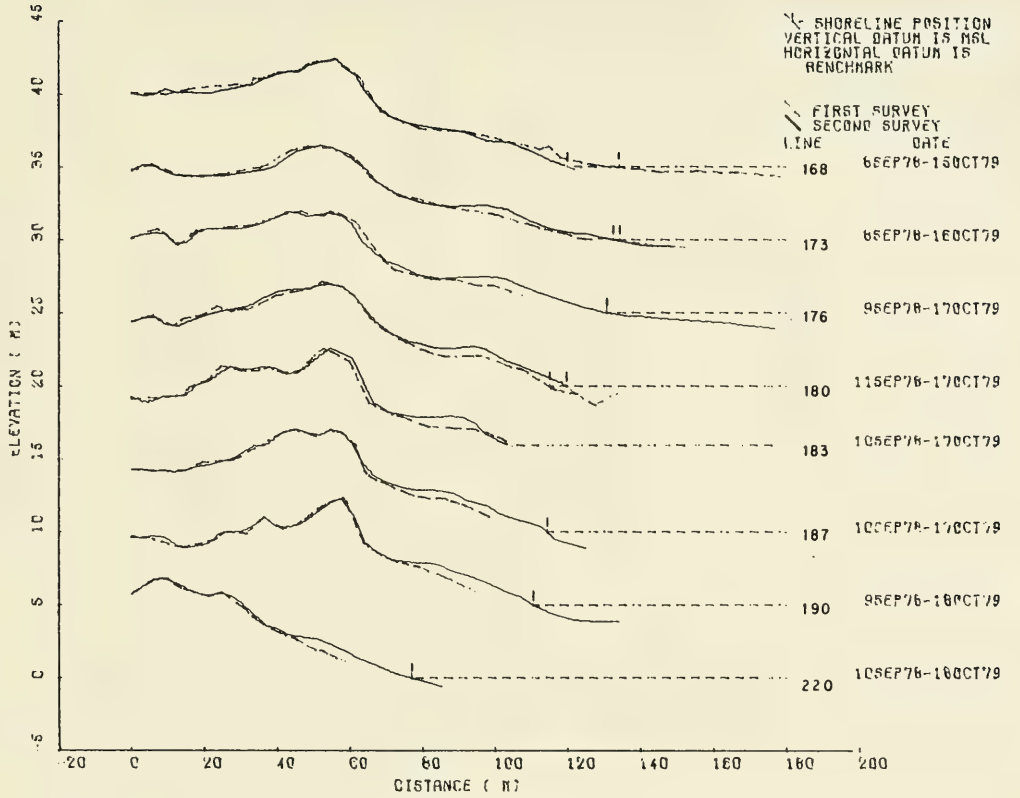


Figure 25. Comparison of beach profiles for the southern range, 1978-79 surveys.

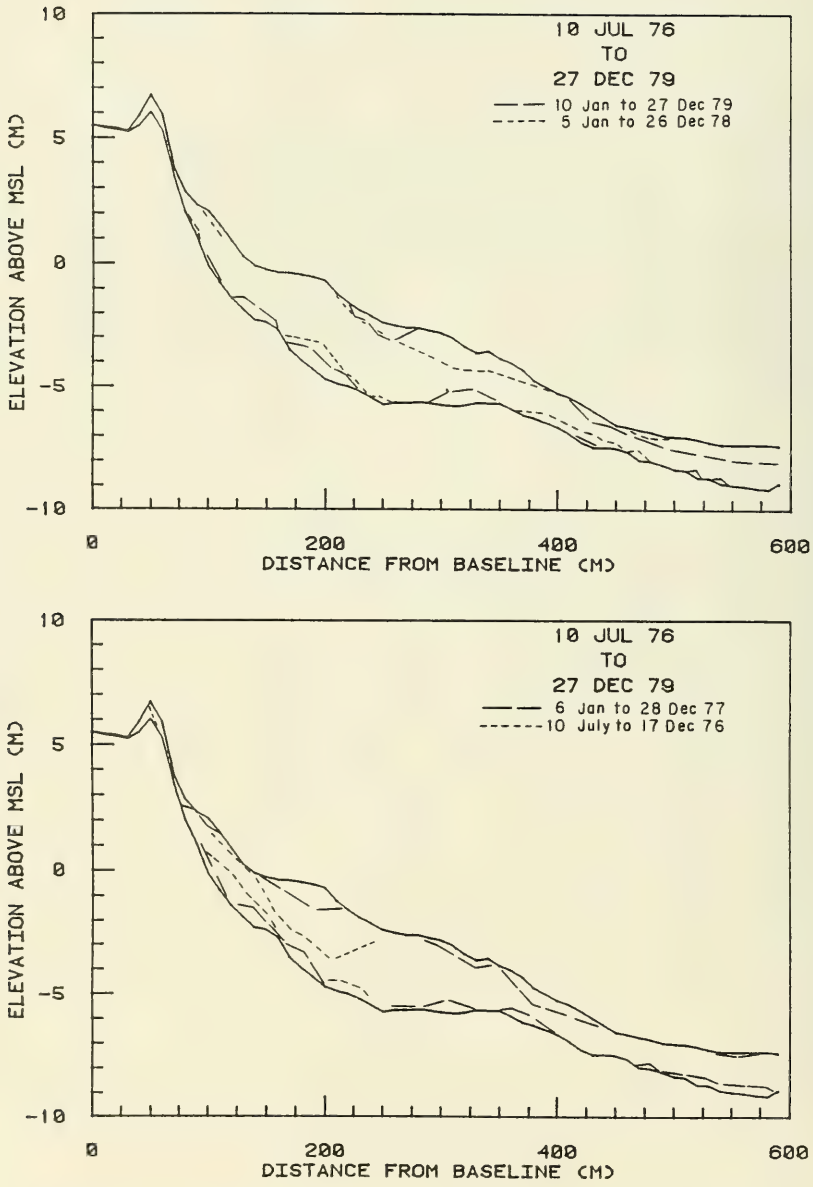


Figure 26. Profile envelopes for the north side of the FRF pier.

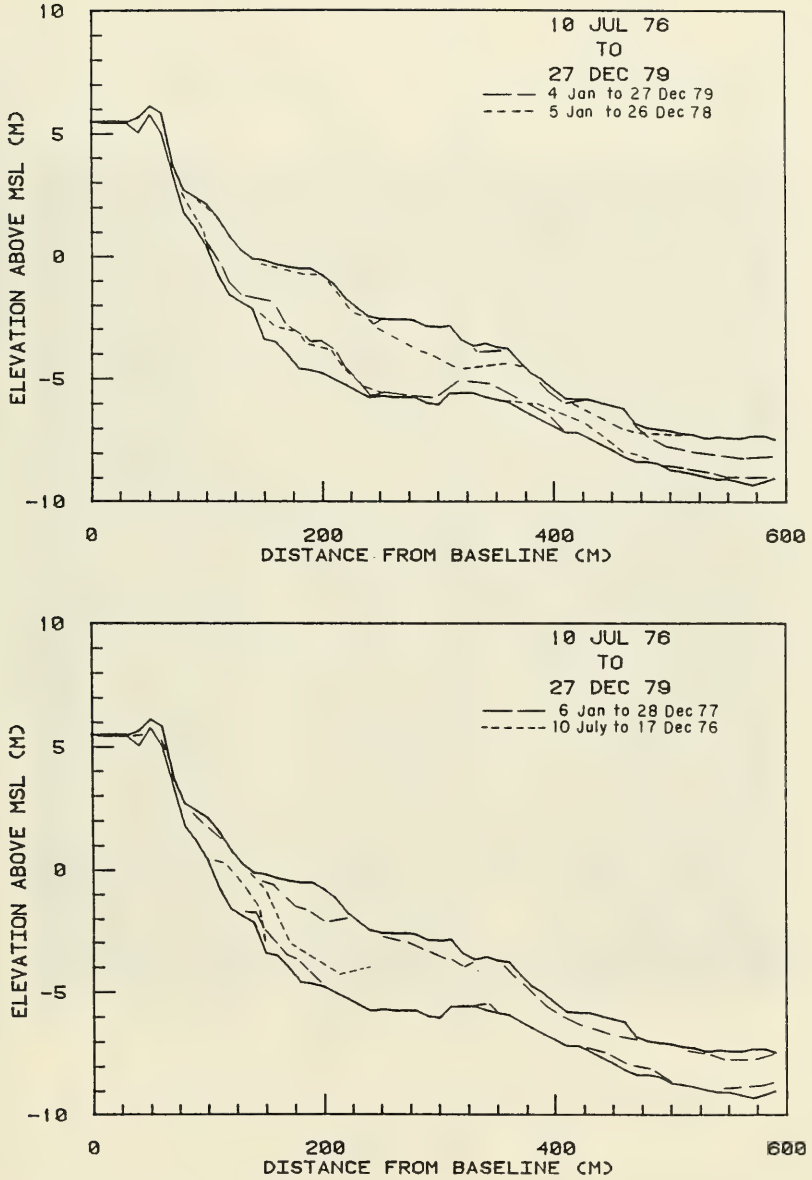


Figure 27. Profile envelopes for the south side of the FRF pier.

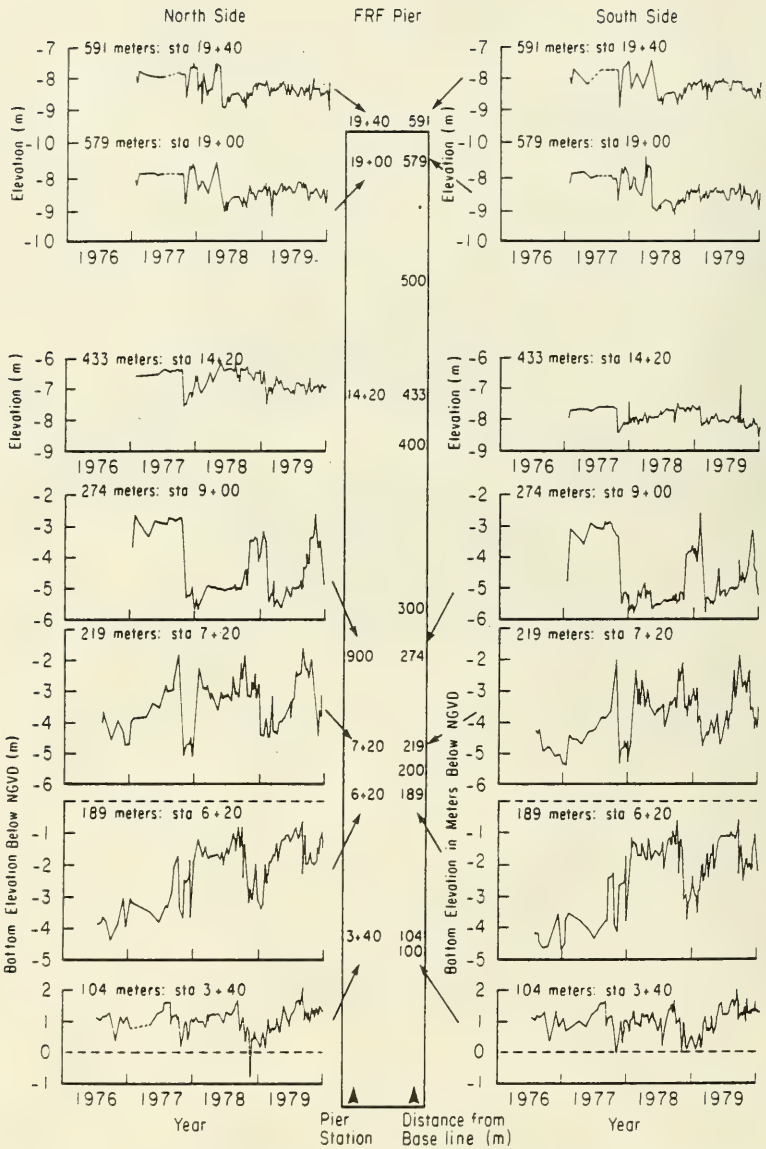


Figure 28. Bottom elevations along the north and south sides of the FRF pier.

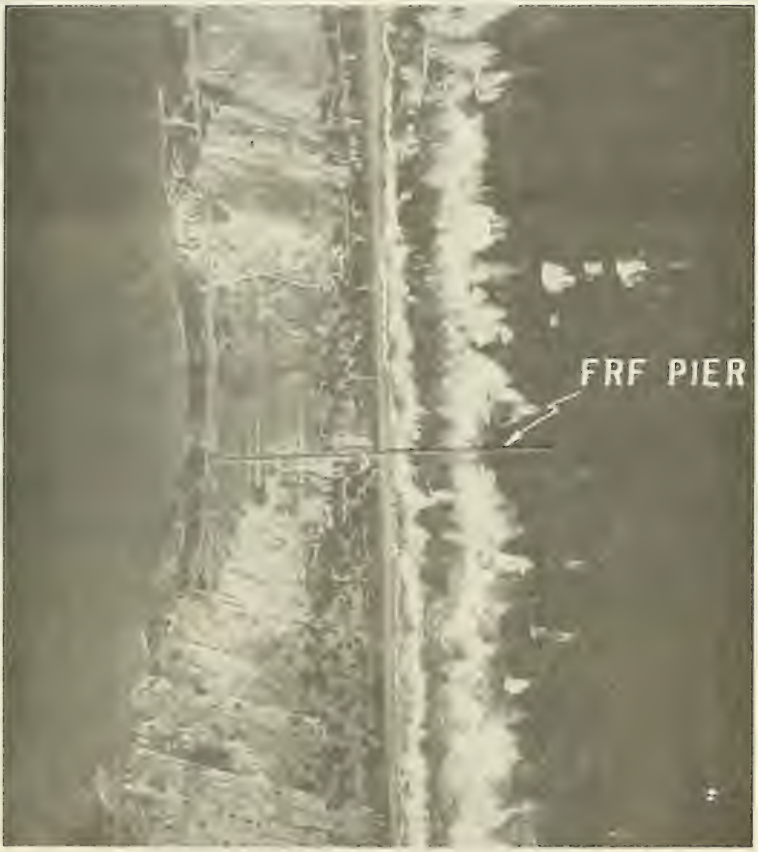
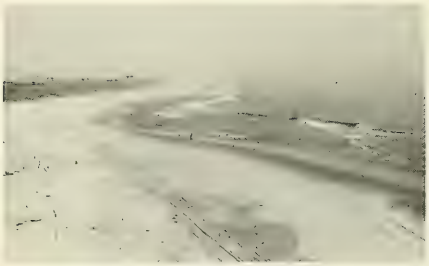


Figure 29. Aerial photo of FRF.



31 Aug. 1979 0715 hr e.s.t.

28 Sept. 1979 1220 hr e.s.t.

31 Oct. 1979 1300 hr e.s.t.

29 Nov. 1979 1430 hr e.s.t.

27 Dec. 1979 1600 hr e.s.t.

Figure 30. Beach photos looking north from the FRF pier.

31 Aug. 1979 0705 hr e.s.t.

28 Sept. 1979 1220 hr e.s.t.

31 Oct. 1979 1300 hr e.s.t.

29 Nov. 1979 1430 hr e.s.t.

27 Dec. 1979 1600 hr e.s.t.

Figure 31. Beach photos looking south from the FRF pier.

VI. REQUESTING DATA

The CERC Coastal Engineering Information and Analysis Center (CEIAC) is responsible for storing and disseminating most of the data presented or alluded to in this report. All data requests should be in writing and addressed to: U.S. Army Coastal Engineering Research Center, Attn: CEIAC, Kingman Building, Fort Belvoir, Virginia 22060. Tidal data other than summaries should be obtained directly from the National Ocean Survey, Attn: Tides Branch, Rockville, Maryland 20850. A complete explanation of the exact data desired for specific dates or times will expedite filling any request. The request should also explain how the data will be used to help determine if other relevant data are available. For information regarding the availability of data, contact CEIAC at (202) 325-7386. Costs for collecting, copying, and mailing will be borne by the requester.

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APPENDIX A

WAVE DATA

This appendix presents summaries of the wave gage data in the following formats:

(a) Gage histories: The gage histories include information about the gage, the gage installation, and times of operation with only minor interruptions. Short interruptions in the operational status of the gage are not mentioned.

(b) Tables of overall annual and monthly maximums, mean and standard deviations of significant height and peak period: The monthly mean significant wave height and standard deviation, monthly mean peak wave period and standard deviation, and the monthly extreme significant heights are listed in these tables. Annual values and statistics for the overall period are also included, along with the total number of observations obtained for each month; at 4 observations per day, the maximum number of observations per month (based on a 30-day month) is 120. From August 1978 to September 1979, 2 observations per day were recorded except during storms and special events; 60 observations were recorded during a 30-day month.

(c) Tables of joint distribution functions of significant height versus peak period: For the overall time of operation of each gage, joint distribution tables are presented which give the frequency of the significant height and peak period within specified intervals, based on the number of observations per 1,000 observations. These values can be converted to percent by dividing by 10. The "row total" gives the total number of observations per 1,000 observations that fell within each specified significant height interval. The "column total" gives the number of observations per 1,000 observations that fell within each specified peak period interval. Observations in the lowest peak period interval usually represented calm conditions; however, these were not computed in the column total. The "cumulative totals" in the table are cumulative totals of the entries in the row total and column total.

Each entry in the "row average" column is the average significant height for all observations within each specified peak period interval. Each entry in the "column average" is the average peak period for all observations within each specified height interval. The row and column averages are useful for investigating the relationship between significant height and peak period.

CERC Form 174-74
18 Mar. 74

COASTAL ENGINEERING RESEARCH CENTER WAVE GAGE HISTORY

COORDINATES: 35°55' N. by 75°36' W. LOCATION: Jenettes Fishing Pier, Nags Head, North Carolina

Type of gage	Beginning of proper operation	End of proper operation	Explanation	Gage length (m)	Gage range (m, MSL)	Water depth (m, MSL)	Distance from seaward end of pier (m)	Pier length (m)
CERC No. 112 Baylor	3 Nov. 72	12 Apr. 77	Moving instrumentation shelter	7.6	-2.4 to 5.2	5.2	47 (on N. side of pier)	229
	13 Apr. 77	6 May 77	Transducer and amplifier replaced					
	12 May 77	6 July 77	Transducer replaced					
	19 July 77	21 July 77	Transducer replaced					
	26 July 77	20 Sept. 77	Lightning struck gage					
	24 Nov. 77	4 Feb. 78	Lightning, problem with electronics					
	1 Mar. 78	19 Mar. 78	Lightning, problem with electronics					
	25 Mar. 78	14 Apr. 78	Lightning, bad transducer					
	21 Apr. 78	27 Apr. 78	Shipwreck damaged pier and data cable					
	1 Aug. 78	19 Sept. 78	No data recorded, recorder problem					
	7 Oct. 78	14 Dec 78	No data recorded, pier power off					
	4 Jan 79	1 Feb. 79	No data recorded					
	18 Feb. 79	16 Mar. 79	No data recorded					
	29 Mar. 79	1 June 79	Multiplexer being repaired					
	8 June 79	22 June 79	Lightning, phoneline problem					
	3 July 79	17 Nov. 79	Phoneline, recorder problems					
	22 Nov. 79	11 Dec. 79	Phoneline, recorder problems					
	19 Dec. 79							

Table A-1. Wave height and period statistics for CERC Baylor gage 112 at Nags Head, North Carolina.

Year and month		Mean height (m)	Std. dev. height (m)	Mean period (s)	Std. dev. period (s)	Extreme height (m)	Date occurred	Obsn. No.	No. of obsns.
1977	Jan.	0.88	0.36	8.73	3.24	1.60	3	4	89
	Feb.	0.67	0.36	8.51	3.09	1.69	16	2	98
	Mar.	0.71	0.28	9.06	2.96	1.43	25	1	118
	Apr.	0.60	0.24	9.48	3.31	1.43	29	2	93
	May	0.49	0.22	8.51	3.00	0.94	30	3	82
	June	0.51	0.25	8.48	1.97	1.65	11	2	91
	July	0.50	0.23	8.67	2.03	1.04	26	4	40
	Aug.	0.43	0.18	8.18	1.96	1.00	20	1	88
	Sept.	0.46	0.15	10.80	3.09	0.94	15	3	47
	Nov.	0.91	0.20	8.41	1.93	1.29	29	4	11
	Dec.	0.98	0.43	10.39	3.61	2.13	21	2	93
	Annual	0.65	0.28	9.02	2.86	2.13			850
1978	Jan.	0.99	0.37	10.19	2.64	2.02	9	2	100
	Feb.	1.20	0.17	6.39	0.80	1.56	2	4	9
	Mar.	1.06	0.37	8.65	2.01	1.87	25	4	82
	Apr.	0.72	0.49	8.83	2.84	2.23	27	3	67
	Aug.	0.54	0.14	9.63	2.10	0.85	21	2	10
	Sept.	0.98	0.40	10.34	1.66	1.87	13	4	45
	Oct.	1.17	0.51	9.71	2.49	1.88	18	2	23
	Nov.	0.89	0.28	8.04	2.02	1.56	22	4	33
	Dec.	0.80	0.33	8.45	2.64	1.55	1	2	14
	Annual	0.95	0.38	9.26	2.30	2.23			383
1979	Jan.	0.95	0.48	9.97	2.11	1.90	19	1	29
	Feb.	1.23	0.26	10.83	2.30	1.60	18	1	8
	Mar.	0.73	0.23	10.21	1.69	1.21	15	3	10
	Apr.	0.69	0.25	9.15	2.61	1.21	26	2	22
	May	0.61	0.28	8.14	2.17	1.40	18	3	23
	June	0.81	0.41	9.44	3.07	1.61	20	3	11
	July	0.51	0.23	9.85	2.44	1.11	5	2	21
	Aug.	0.56	0.19	9.69	3.28	1.04	16	3	21
	Sept.	0.94	0.44	8.92	2.53	1.85	24	2	46
	Oct.	0.62	0.31	9.14	3.17	1.55	10	3	65
	Nov.	0.90	0.37	8.73	1.72	1.72	14	2	60
	Dec.	0.89	0.43	9.45	2.62	1.85	21	2	52
	Annual	0.76	0.35	9.24	2.50	1.90			368
	Overall	0.75	0.32	9.13	2.66	2.23			1,601

Table A-2. Joint distribution of significant wave height versus peak period at Nags Head, North Carolina.

1601 OBSERVATIONS SUMMARY FOR JAN 77 DEC 79

PERIOD (SECS)	SIG. HEIGHT (FT)															
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOT.*	CUM. TOT.*	ROW AVG.*
0.0 - .9																1000	0.00
1.0 - 1.9																1000	0.00
2.0 - 2.9		4													4	1000	1.50
3.0 - 3.9		5	4	1	1										11	996	2.39
4.0 - 4.9		7	13	12	1	1									34	985	2.72
5.0 - 5.9		14	32	21	15	2									84	951	3.00
6.0 - 6.9	2	20	23	27	16	4	1								94	867	3.03
7.0 - 7.9	4	29	17	12	12	3									79	773	2.61
8.0 - 8.9	23	129	58	24	21	12	3								270	695	2.28
9.0 - 9.9	7	65	27	22	8	4	2								136	424	2.35
10.0 -10.9	4	36	33	13	6	5	1	1							99	288	2.53
11.0 -11.9																189	0.00
12.0 -12.9	8	36	20	12	7	4	2								91	189	2.47
13.0 -13.9																99	0.00
14.0 -14.9	6	47	9	4	2	3		1							72	99	2.04
15.0 -15.9																26	0.00
16.0 -16.9	1	11	8	1		1	2								25	26	2.48
17.0 -17.9																1	0.00
18.0 -18.9																1	0.00
19.0 -19.9																1	0.00
20.0 -20.9		1													1	1	1.50
21.0 +																	0.00
TOTAL	57	405	244	152	89	39	12	2									2.49
CUM. TOTAL	1000	943	538	294	142	54	14	2									
COL. AVG.	9.96*	9.68	8.74	8.18	8.10	9.44	11.05	13.17	0.00	0.00	0.00	0.00	0.00	0.00	9.11		

CERC Form 174-74
18 Mar. 74

COASTAL ENGINEERING RESEARCH CENTER WAVE GAGE HISTORY

COORDINATES: 36°10'54" N. by 75°45'50" W.

LOCATION: Field Research Facility, Duck, North Carolina (pier station 6+20)

Type of gage	Beginning of proper operation	End of proper operation	Explanation	Gage length (m)	Gage range (m, MSL)	Water depth (m, MSL[1])	Distance from base line (m)
CERC No. 615 Baylor	1 Nov. 77	15 Nov. 77	Transducer problem	8.5	-1.6 to 7.0	2.3	189
	29 Nov.77	10 Dec. 77	Recalibrated, bias level too low				
	16 Dec. 77	19 Mar. 78	Lightning, problem with electronics				
	25 Mar. 78	14 Apr. 78	Problem with electronics				
	19 Apr. 78	4 June 78	Lightning, bad transducer				
	15 June 78	18 June 78	Bad transducer	7.6	-0.6 to 7.0		
	27 June 78	27 June 78	Upgrading electronics at FRF				
	1 Aug. 78	28 Sept. 78	Recorder problem				
	7 Oct. 78	14 Dec. 78	No data recorded				
	4 Jan. 79	1 Feb. 79	No data recorded				
	18 Feb. 79	1 Mar. 79	Data cable cut by building contractor				
	7 June 79	17 Nov. 79	Phoneline, recorder problems				
	22 Nov. 79	11 Dec. 79	Phoneline, recorder problems				
	19 Dec. 79						

[1]Median depth from pier profiles taken on south side of pier from July 77 to June 79.

Table A-3. Wave height and period statistics for CERC Baylor gage 615 at pier station 6+20.

Year and month	Mean height (m)	Std. dev. height (m)	Mean period (s)	Std. dev. period (s)	Extreme height (m)	Date occurred	Obsn. No.	No. of obsns.
1977 Nov.	0.98	0.26	9.25	2.20	1.38	3	3	54
Dec.	0.66	0.42	9.14	4.25	1.71	20	1	90
Annual	0.78	0.36	9.18	3.48	1.71			144
1978 Jan.	0.70	0.36	8.58	3.86	1.93	9	2	100
Feb.	0.84	0.32	8.58	3.96	1.85	22	2	87
Mar.	0.84	0.32	7.64	2.50	1.58	25	4	85
Apr.	0.68	0.40	7.56	3.40	2.07	28	1	61
May	0.63	0.25	7.14	2.00	1.18	27	1	53
June	0.47	0.16	7.88	1.48	0.88	15	1	9
Aug.	0.35	0.17	9.68	2.64	0.98	21	2	16
Sept.	0.58	0.27	10.01	2.81	1.48	13	4	46
Oct.	0.76	0.33	10.67	3.33	1.40	18	2	23
Nov.	0.70	0.23	6.91	2.07	1.02	13 29	3 3	34
Dec.	0.61	0.26	7.04	2.02	1.27	1	2	14
Annual	0.71	0.31	8.25	3.06	2.07			528
1979 Jan.	0.69	0.31	8.83	2.83	1.30	24	3	25
Feb.	1.03	0.28	11.16	2.34	1.32	18	2	10
June	0.57	0.20	10.00	3.80	1.01	20	3	13
July	0.42	0.13	7.63	2.61	0.73	5	3	16
Aug.	0.43	0.11	9.98	3.98	0.61	24	2	19
Sept.	0.66	0.29	10.10	3.90	1.22	24 25	2 2	46
Oct.	0.52	0.31	7.95	3.80	1.40	24	2	54
Nov.	0.83	0.52	7.86	2.44	1.57	14	2	56
Dec.	0.76	0.46	9.65	2.64	1.73	21	3	26
Annual	0.66	0.33	8.86	3.21	1.73			265
Overall	0.71	0.32	8.57	3.18	2.07			937

Table A-4. Joint distribution of significant wave height versus peak period at FRF nearshore Baylor gage 615.

793 OBSERVATIONS SUMMARY FOR JAN 78 DEC 79

PERIOD (SECS)	SIG. HEIGHT (FT) 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOT.*	CUM. TOT.*	ROW AVG.*
0.0 - .9																1000	0.00
1.0 - 1.9																1000	0.00
2.0 - 2.9	1	5	2												9	1000	1.64
3.0 - 3.9		17	9	1											27	991	1.91
4.0 - 4.9	5	40	31	5											81	964	1.95
5.0 - 5.9	10	71	95	40	7										223	883	2.34
6.0 - 6.9	5	20	25	22	12										85	659	2.71
7.0 - 7.9	4	5	6	11	5	1									32	574	2.88
8.0 - 8.9	15	54	32	36	16		1								155	542	2.44
9.0 - 9.9	11	56	19	16	7	2									112	387	2.14
10.0 -10.9	12	30	19	6	2	5	2								77	275	2.26
11.0 -11.9																197	0.00
12.0 -12.9	4	34	24	12	10	4	1								89	197	2.58
13.0 -13.9																109	0.00
14.0 -14.9	22	22	15	16	1	1									79	109	1.93
15.0 -15.9																30	0.00
16.0 -16.9	6	15	2	1											25	30	1.45
17.0 -17.9																5	0.00
18.0 -18.9																5	0.00
19.0 -19.9																5	0.00
20.0 -20.9	2	1	1												5	5	1.25
21.0 +																	0.00
TOTAL	98	371	281	169	62	14	5										2.29
CUM. TOTAL	1000	901	531	250	81	19	5										
COL. AVG.	10.47*	8.46	7.62	8.40	8.62	10.95	10.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.47		

CERC Form 174-74
18 Mar. 74

COASTAL ENGINEERING RESEARCH CENTER WAVE GAGE HISTORY

COORDINATES: 36°10'54" N. by 75°45'50" W.

LOCATION: Field Research Facility, Duck, North Carolina (pier station 19+00)

Type of gage	Beginning of proper operation	End of proper operation	Explanation	Gage length (m)	Gage range (m, MSL)	Water depth (m, MSL[1])	Distance from base line (m)
CERC No. 625 Baylor	11 Nov. 77	23 Nov. 77	Noisy	9.4	-2.1 to 7.0	8	579
	29 Nov. 77	10 Dec. 77	Full scale, erratic problem with electronics				
	16 Dec. 77	21 Mar. 78	Full scale, erratic problem with electronics				
	25 Mar. 78	14 Apr. 78	Problem with electronics				
	18 Apr. 78	4 June 78	Problem with electronics				
	15 June 78	28 June 78	Upgrading electronics at FRF				
	1 Aug. 78	28 Sept. 78	Recorder problem				
	7 Oct. 78	14 Dec.78	No data recorded				
	4 Jan. 79	1 Feb. 79	No data recorded				
	18 Feb. 79	16 Mar. 79	No data recorded				
	29 Mar. 79	19 May 79	Transducer malfunction				
	7 June 79	21 June 79	Gage failure				
	27 June 79	17 Nov. 79	Phoneline, recorder problems				
	22 Nov. 79	11 Dec. 79	Phoneline, recorder problems				
	19 Dec. 79						

[1]Median depth from pier profiles taken on south side from July 77 to June 79.

Table A-5. Wave height and period statistics for CERC Baylor gage 625 at pier station 19+00.

Year and month		Mean height (m)	Std. dev. height (m)	Mean period (s)	Std. dev. period (s)	Extreme height (m)	Date occurred	Obsn. No.	No. of obsns.
1977	Nov.	0.73	0.26	8.38	1.90	1.28	29	4	29
	Dec.	1.05	0.75	9.81	3.70	3.56	19	3	96
	Annual	0.98	0.64	9.48	3.28	3.56			125
1978	Jan.	0.98	0.50	9.52	2.85	2.65	20	1	112
	Feb.	1.15	0.49	9.26	3.64	3.00	22	2	91
	Mar.	1.28	0.48	8.33	2.11	2.58	25	4	84
	Apr.	0.94	0.77	8.52	3.24	3.34	26	3	79
	May	0.76	0.25	7.93	2.11	1.33	4	4	61
	June	0.54	0.12	8.30	1.59	0.74	16 17	1 2	26
	Aug.	0.57	0.15	9.71	2.08	0.99	21	2	18
	Sept.	0.99	0.52	9.69	2.05	2.62	13	4	48
	Oct.	1.39	0.67	10.56	2.58	2.45	17 30	3 3	22
	Nov.	1.04	0.31	7.81	1.86	1.79	13	3	35
	Dec.	0.92	0.35	7.74	1.77	1.72	1	3	14
	Annual	1.01	0.47	8.87	2.60	3.34			590
1979	Jan.	1.03	0.50	8.88	2.91	2.13	24	3	33
	Feb.	1.65	0.40	10.25	2.70	2.04	17	4	10
	Mar.	0.91	0.37	9.92	2.04	1.80	15	3	11
	Apr.	0.81	0.29	8.65	2.49	1.66	13	3	23
	May	0.69	0.39	8.23	2.64	1.73	18	3	19
	June	0.98	0.40	7.55	1.79	1.55	20	3	13
	July	0.56	0.18	8.10	1.58	1.05	5	2	24
	Aug.	0.54	0.12	10.76	3.87	0.80	3	3	12
	Sept.	1.00	0.51	9.35	3.01	2.37	24	4	50
	Oct.	0.64	0.30	9.18	3.06	1.73	10	3	69
	Nov.	0.89	0.36	8.31	1.82	1.69	14	2	65
	Dec.	1.03	0.64	9.54	2.62	2.74	20	4	53
	Annual	0.87	0.40	8.97	2.56	2.74			382
Overall		0.96	0.46	8.97	2.66	3.56			1,097

Table A-6. Joint distribution of significant wave height versus peak period at FRF pier-end Baylor gage 625.

972 OBSERVATIONS SUMMARY FOR JAN 78 DEC 79

PERIOD (SECS)	SIG. HEIGHT (FT)															
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOT.*	CUM. TOT.*	ROW AVG.*
0.0 - .9																1000	0.00
1.0 - 1.9																1000	0.00
2.0 - 2.9	1	3													4	1000	1.25
3.0 - 3.9		4	11												15	996	2.23
4.0 - 4.9		3	14	14	1	1									34	980	2.98
5.0 - 5.9		21	43	38	24	5	3	1							135	947	3.23
6.0 - 6.9	1	25	15	18	8	15	9	1	2						96	812	3.64
7.0 - 7.9		20	7	6	8	9		2	1	1					54	716	3.50
8.0 - 8.9	3	75	66	29	16	13	7	2	2						214	662	2.84
9.0 - 9.9	2	58	52	13	16	4	7	5		1	2				161	448	2.96
10.0 -10.9	2	34	34	18	19	3	2	1			2				112	287	2.95
11.0 -11.9																175	0.00
12.0 -12.9		16	28	16	11	6	9	3	3	2	1				97	175	3.89
13.0 -13.9																78	0.00
14.0 -14.9		20	10	12	16	5		1							65	78	3.21
15.0 -15.9																13	0.00
16.0 -16.9	2	8	2	1											13	13	1.65
TOTAL	11	286	284	168	117	63	38	16	8	4	5						3.14
CUM. TOTAL	1000	989	703	419	252	135	72	34	17	9	5						
COL. AVG.	9.77*	9.17	8.60	8.40	9.28	8.60	9.04	9.63	9.38	10.50	10.50	0.00	0.00	0.00	8.88		

CERC Form 174-74
18 Mar. 74

COASTAL ENGINEERING RESEARCH CENTER WAVE GAGE HISTORY

COORDINATES: 36°11.1' N. by 75°44.7' W. LOCATION: Field Research Facility, Duck, North Carolina

Type of gage	Beginning of proper operation	End of proper operation	Explanation	Gage length (m)	Gage range (m, MSL)	Water depth (m, MSL[1])	Distance from pier (m)	Pier length (m)
CERC No. 610 nearshore Waverider buoy	1 Aug. 78	29 Sept. 78	Recorder problem	10	±5	7	109 NE. of seaward end of FRF pier (0.6 km offshore)	597
	7 Oct. 78	14 Dec. 78	No data recorded					
	4 Jan. 79	1 Feb. 79	No data recorded					
	17 Feb. 79	16 Mar. 79	No data recorded					
	29 Mar. 79	1 June 79	Multiplexer off for repairs					
	7 June 79	20 July 79	Antenna (cable) problem					
	31 July 79	24 Aug. 79	Discriminator pulled out					
	31 Aug. 79	17 Nov. 79	Phoneline, recorder problems					
	22 Nov. 79	11 Dec. 79	Phoneline, recorder problems					
	18 Dec. 79							

[1] Depth from 1978 bathymetric survey.

Table A-7. Wave height and period statistics for CERC nearshore Waverider buoy gage 610.

Year and month		Mean height (m)	Std. dev. height (m)	Mean period (s)	Std. dev. period (s)	Extreme height (m)	Date occurred	Obsn. No.	No. of obsns.
1978	Aug.	0.76	0.13	8.00	2.85	1.09	21	2	9
	Sept.	1.15	0.45	10.02	1.99	2.41	13	4	50
	Oct.	1.37	0.63	10.43	2.52	2.76	17	3	18
	Nov.	1.25	0.29	7.60	1.52	1.96	13	3	32
	Dec.	1.07	0.35	8.26	2.57	1.87	1	2	14
	Annual	1.17	0.40	9.10	2.07	2.76			123
1979	Jan.	1.13	0.53	8.41	2.88	2.28	24	3	32
	Feb.	1.87	0.39	9.23	2.18	2.33	17	4	8
	Mar.	1.22	0.29	10.45	2.30	2.01	15	3	11
	Apr.	1.23	0.14	9.61	2.53	2.01	13	3	22
	May	1.19	0.31	8.67	3.39	1.93	18	3	19
	June	1.32	0.30	7.18	3.62	1.87	20	3	16
	July	1.14	0.14	9.76	2.61	1.40	11	3	18
	Aug.	1.09	0.16	10.45	4.48	1.44	23	3	15
	Sept.	1.15	0.59	9.55	2.48	2.65	24	3	41
	Oct.	0.66	0.33	9.06	2.86	1.91	10	4	42
	Nov.	1.09	0.40	8.42	1.53	1.87	14	2	49
	Dec.	1.29	0.79	9.68	2.57	3.32	21	1	42
	Annual	1.13	0.43	9.25	2.64	3.32			315
	Overall	1.14	0.42	9.21	2.48	3.32			438

Table A-8. Joint distribution of significant wave height versus peak period at FRF nearshore Waverider buoy gage 610.

438 OBSERVATIONS SUMMARY FOR AUG 78 DEC 79

PERIOD (SECS)	SIG. HEIGHT (FT)																
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOT.*	CUM. TOT.*	RUN AVG.*
0.0 - .9																1000	0.00
1.0 - 1.9																1000	0.00
2.0 - 2.9																1000	0.00
3.0 - 3.9			5	5											9	1000	3.00
4.0 - 4.9		2	9	11	5										27	991	3.17
5.0 - 5.9			21	11	39	11	11	2							96	963	4.38
6.0 - 6.9		7	16	27	23	14	16								103	868	4.17
7.0 - 7.9		9	9	16	7	16	5	5		2					68	765	4.33
8.0 - 8.9		34	71	78	32	11	5	2	2		2				237	696	3.36
9.0 - 9.9	2	30	43	55	14	7	2	7	2						162	459	3.27
10.0 -10.9		14	30	30	23	5	5	5	2						112	297	3.66
11.0 -11.9																185	0.00
12.0 -12.9		7	9	41	18	11	5	7	5	2					105	185	4.41
13.0 -13.9																80	0.00
14.0 -14.9		7	7	25	9	5	2				2				57	80	3.86
15.0 -15.9																23	0.00
16.0 -16.9		5	2	14											21	23	2.94
17.0 -17.9																2	0.00
18.0 -18.9																2	0.00
19.0 -19.9																2	0.00
20.0 -20.9			2												2	2	2.50
21.0 +																	0.00
TOTAL	2	114	224	313	169	80	50	27	11	5	5						3.75
CUM. TOTAL	1000	998	884	660	347	178	98	48	21	9	5						
COL. AVG.	9.90*	9.64	8.79	9.67	8.80	8.64	7.95	9.67	10.70	10.00	11.50	0.00	0.00	0.00	9.12		

CERC Form 174-74
18 Mar. 74

COASTAL ENGINEERING RESEARCH CENTER WAVE GAGE HISTORY

COORDINATES: 36°11.1' N. by 75°44.4' W. LOCATION: Field Research Facility, Duck, North Carolina

Type of gage	Beginning of proper operation	End of proper operation	Explanation	Gage length (m)	Gage range (m, MSL)	Water depth (m, MSL[1])	Distance from pier (km)	Pier length (m)
CERC No. 620 offshore Waverider buoy	1 Aug. 78	29 Sept. 78	Recorder problem	10	±5	18	2.4 E. of the seaward end of FRF pier (3 km offshore)	561
	7 Oct. 78	22 Nov. 78	Cut loose by fishing trawler (recovered at Port of Wancheese)					
	14 Dec. 78	14 Dec. 78	No data recorded					
	4 Jan. 79	1 Feb. 79	No data recorded					
	17 Feb. 79	16 Mar. 79	No data recorded					
	29 Mar. 79	1 June 79	Multiplexer off for repairs					
	7 June 79	17 Nov. 79	Phoneline, recorder problems					
	22 Nov. 79	11 Dec. 79	Phoneline, recorder problems					
	18 Dec. 79							

[1] Depth from 1978 bathymetric survey.

Table A-9. Wave height and period statistics for CERC offshore Waverider buoy gage 620.

Year and month		Mean height (m)	Std. dev. height (m)	Mean period (s)	Std. dev. period (s)	Extreme height (m)	Date occurred	Obsn. No.	No. of obsns.
1978	Aug.	0.74	0.16	8.78	2.18	1.19	21	2	12
	Sept.	1.18	0.47	9.56	1.86	2.78	13	4	51
	Oct.	1.58	0.74	9.19	2.17	2.99	17	3	22
	Nov.	1.19	0.25	7.37	1.46	1.82	13	3	22
	Annual	1.06	0.44	8.95	1.88	2.99			107
1979	Jan.	1.29	0.53	7.97	2.86	2.45	19	1	31
	Feb.	1.67	0.51	9.62	2.52	2.23	17	3	8
	Mar.	1.07	0.38	8.95	2.48	1.99	15	3	11
	Apr.	0.97	0.26	7.95	2.63	1.78	13	3	21
	May	0.95	0.39	7.73	2.30	2.11	17	2	23
	June	1.14	0.36	8.56	4.00	1.77	20	3	15
	July	0.73	0.21	7.85	1.96	1.33	5	2	20
	Aug.	0.76	0.27	8.82	3.37	1.38	16	3	20
	Sept.	1.12	0.54	9.40	2.76	2.45	24	4	50
	Oct.	0.81	0.39	8.13	3.03	2.34	10	3	60
	Nov.	1.11	0.47	8.01	1.88	2.33	12	3	60
	Dec.	1.27	0.70	9.44	2.63	3.13	20	4	47
	Annual	1.06	0.45	8.50	2.64	3.13			366
	Overall	1.06	0.45	8.60	2.47	3.13			473

Table A-10. Joint distribution of significant wave height versus peak period at FRF offshore Waverider buoy gage 620.

473 OBSERVATIONS SUMMARY FOR AUG 78 DEC 79

PERIOD (SECS)	SIG. HEIGHT (FT)														CUM.	ROW
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOT.*	TOT.*	AVG.*
0.0 - .9																1000	0.00
1.0 - 1.9																1000	0.00
2.0 - 2.9		2	4												6	1000	2.17
3.0 - 3.9		2	6	4											13	994	2.67
4.0 - 4.9		2	13	25	11	4		2							57	981	3.69
5.0 - 5.9		8	21	19	32	25	8	4							118	924	4.23
6.0 - 6.9		13	23	21	15	11	6	8		2					99	806	4.03
7.0 - 7.9		13	32	19	11	2	2	2	4	2					86	707	3.57
8.0 - 8.9		36	84	55	21	21	4	11		2	2				236	620	3.46
9.0 - 9.9		30	63	32	8	2	6	4							146	384	2.99
10.0 -10.9		23	36	15	19	6	4	6							110	238	3.38
11.0 -11.9																129	0.00
12.0 -12.9		2	23	19	15	11	6	2	2	2					82	129	4.22
13.0 -13.9																46	0.00
14.0 -14.9		8	13	2		2	2				2				30	46	3.36
15.0 -15.9																17	0.00
16.0 -16.9		4	11	2											17	17	2.38
TOTAL		143	329	213	131	84	40	40	6	8	4						3.58
CUM. TOTAL	1000	1000	857	527	314	184	99	59	19	13	4						
COL. AVG.	0.00*	9.01	8.92	8.15	7.95	7.95	8.82	8.13	9.17	8.75	11.50	0.00	0.00	0.00	8.54		

APPENDIX B

METEOROLOGICAL DATA

This appendix presents summaries of the meteorological data in the following formats:

(a) Chart log: The starting and ending dates for periods of time when there were no gaps or only minor gaps in the operational status of the meteorological instruments with analog (chart) recording capabilities.

(b) Keynotes on meteorological observations: A list of observation symbols and their respective interpretation is provided for use in interpreting the monthly meteorological data tables.

(c) Monthly data tables: The daily meteorological observations are tabulated by month. The "amount of precipitation" represents the total precipitation since the last reset of the rain gage (i.e., the bucket was emptied); consequently, the values entered on a Monday would represent the total rainfall since the previous reading on the past Friday. The same situation holds true for the maximum and minimum thermometers which are also manually reset. The values reported represent the temperature extremes since the last resetting.

METEOROLOGICAL INSTRUMENTS CHART LOG

Instrument	Sample chart[1]	Starting date	Ending date
Barograph	a	3 Mar. 78	29 Apr. 78
		2 May 78	31 Dec. 79
Rain gage	b	6 Mar. 78	31 Dec. 79
Pyranograph	c	18 Jan. 79	31 Dec. 79

[1] See Figure 3.

KEYNOTES ON METEOROLOGICAL OBSERVATIONS

1. Prevailing weather conditions.

   (a) Type: WS - Water spout
   TH - Thunderstorm
   FD - Freezing drizzle
   F - Fog
   SS - Snow shower
   RS - Rain shower
   H - Hail
   S - Snow
   R - Rain
   D - Drizzle
   K - Haze or smoke

   (b) Intensity: (+) - Unusually intense
   (-) - Mild conditions

2. Pressure trends.

   (a) First number indicates characteristic of change:

   0 - Increasing then decreasing.
   1 - Increasing then steady or increasing more slowly.
   2 - Increasing either steady or unsteady.
   3 - Decreasing or steady then increasing; or increasing then increasing more rapidly.
   4 - Steady.
   5 - Decreasing then increasing.
   6 - Decreasing then steady or decreasing more slowly.
   7 - Decreasing steady or unsteady.
   8 - Steady or increasing then decreasing; or decreasing then decreasing more slowly.

   (b) The next two numbers indicate code of the amount of change in last 3 hours; higher numbers indicate more change:

   00 = 0.0 millibars
   51 = 5.1 millibars
   100 = 10.0 millibars
   200 = 20.0 millibars

3. WFG: A (+) symbol is entered if the windspeed varies more than 5 meters per second.

4. VAR: The peak value of the windspeed is entered under (VAR) when the peak value exceeds the value of the windspeed by at least 5 meters per second.

Table B-1. Meteorological observations, March 1978.

Day (time 0800)	Prevailing weather conditions[1] Type	Inten.	Cloud cover (pct)	Amount of precipitation (mm)	Atmospheric pressure (mb)	Temperature (°C) High	Low	Land Wind-speed (m/s)	Wind direction (true N.)
2				19	1024.6	0.0	-5.0	4.1	360
3	F		100	6	1007.7	4.4	-2.2	5.1	90
6			100	29	1026.6	11.1	-3.9	4.1	230
7			100	0	1028.0	6.1	-1.1	3.6	50
8	F/R		100	3	1024.9	4.4	1.1	5.1	50
9	F			10	1017.8	5.0	0.6	5.1	360
10	F/R		100	34	996.2	8.9	1.7	3.1	270
13			0	1	1024.6	15.6	2.2	4.6	360
14			50	0	1018.2	16.1	4.4	7.7	180
15			0	0	1013.1	18.9	5.6	1.5	50
16			100	0	1013.8	16.7	5.0	2.1	50
17			100	0	1018.2	22.2	2.8	6.2	320
20			0	0	1024.9	16.7	1.1	4.6	50
21	K			0	1022.9	12.8	3.3	4.6	230
22			0	0	1018.2	20.0	8.9	7.2	50
23			0	0	1019.5	11.1	5.6	2.6	180
24	F		0	0	1020.5	16.1	6.7	2.1	130
27	F	(-)		49	1007.7	15.6	6.7	3.1	270
28	K			0	1017.8	16.1	8.3	2.1	50
29			0	0	1018.5	13.9	8.3	5.1	230
30			0	1	1022.6	22.2	6.7	7.7	50
31			50		1023.9	10.0	2.2	3.6	270

[1] See keynotes.

Table B-2. Meteorological observations, April 1978.

Day	Time	Prevailing weather conditions[1] Type	Inten.	Cloud cover (pct)	Amount of precipitation (mm)	Atmospheric pressure (mb)	Temperature (°C) High	Low	Land Wind-speed (m/s)	Wind direction (true N.)
3	0800			100	0	1047	23.9	7.2	7.2	50
4	0800			100	0	1034	10.6	7.8	1.5	50
5	0800			0	0	1003	21.1	10.0	3.6	230
6	0800			50	0	1020	25.0	8.9	5.1	50
7	0800			0	0	996	18.9	9.4	5.7	270
10	0800			50	0	1006	24.4	6.7	3.1	130
11	0800			0	0	984	23.3	12.2	6.2	230
12	0800			50	6	997	26.1	8.9	2.1	130
13	0800	R	(-)	100	0	991	16.7	11.1	3.1	230
14	0800			0	7	1012	17.8	8.9	5.1	360
17	0800			100	0	1026	20.6	7.2	3.1	90
18	0800			100	0	1011	12.2	8.9	4.1	90
19	0800			100	8	976	17.8	10.0	3.1	180
20	0800			0	4	958	19.4	11.1	8.2	270
21	0800			0	0	975	19.4	11.1	4.1	270
24	0800			0	0	1003	20.0	5.0	5.1	270
26	1030	R		100	31	956	23.9	9.4	15.4	50
27	0800	R	(-)	100	18	954	12.2	8.3	12.9	50
28	0800			0	2	986	12.2	6.7	7.7	270

[1] See keynotes.

Table B-3. Meteorological observations, May 1978.

Day (time 0700)	Prevailing weather conditions[1] Type	Cloud cover (pct)	Amount of precipitation (mm)	Atmospheric pressure (mb)	Temperature (°C) High	Temperature (°C) Low	Land Wind-speed (m/s)	Land Wind direction (true N.)
1		100	4	1006.3	20.6	9.4	2.1	320
2		50	0	1012.4	14.4	7.8	6.2	50
3		0	0	1015.5	15.0	9.4	4.1	50
4	TH	100	6	1013.1	15.6	11.7	3.6	90
5		100	61	1007.7	20.6	11.7	5.1	270
8	R/F	100	18	1022.9	15.6	9.4	3.6	90
9		100	20	1014.4	18.3	12.8	5.1	230
10		0	4	1014.4	21.1	12.8	3.1	360
11		0	0	1025.6	18.3	11.1	2.1	320
12		0	0	1025.3	18.3	12.2	2.6	90
15		50	25	1004.6	24.4	11.7	2.6	230
16		50	1	1007.0	21.7	12.2	3.6	270
17		0	0	1016.1	21.7	13.9	3.6	230
18		50	1	1020.9	23.9	15.6	1.0	130
19		50	0	1018.8	25.0	17.2	3.6	360
22		100	0	1021.2	29.4	16.7	5.1	50
23		100	0	1022.6	19.4	15.0	2.6	90
24		100	0	1017.8	21.7	16.7	3.6	180
25		100	1	1015.1	28.9	17.2	3.6	360
26		50	0	1017.2	23.6	16.7	4.1	50
30		100	3	1014.4	24.4	17.2	2.1	270
31		100	0	1013.3	23.9	17.2	2.1	130

[1] See keynotes.

Table B-4. Meteorological observations, June 1978.

Day (time 0700)	Prevailing weather conditions[1] Type	Cloud cover (pct)	Amount of precipitation (mm)	Atmospheric pressure (mb)	Temperature (°C) High	Temperature (°C) Low	Land Wind-speed (m/s)	Land Wind direction (true N.)
1	TH	0	2	1013.8	22.8	17.2	2.1	320
2		0	0	1018.5	25.0	17.8	2.1	50
5		0	11	1017.8	22.2	14.4	5.7	230
6		0	0	1019.2	27.8	21.7	2.1	230
7		0	1	1020.2	27.8	22.2	4.1	180
8		50	0	1016.1	28.3	23.3	5.1	230
9	R	100	79	1012.1	31.1	19.4	6.2	230
12		0	0	1024.3	22.2	18.9	1.5	130
13		50	0	1015.8	25.6	18.9	5.1	230
14		50	5	1022.2	26.7	16.1	6.2	20
15		0	0	1027.0	20.0	12.2	2.1	320
16		0	0	1026.6	22.2	15.0	1.5	50
19		0	0	1020.9	27.8	22.2	5.1	230
20		50	0	1020.9	29.4	22.2	6.2	230
21		0	0	1019.9	29.4	22.8	4.1	230
22		50	3	1017.8	29.4	16.7	3.1	230
23		50	11	1018.2	27.2	16.1	2.1	50
26		50	0	1019.9	26.7	18.9	3.1	130
27		100	1	1016.8	29.4	23.9	5.1	230
28		50	6	1015.5	29.4	20.6	2.6	180
29		50	0	1017.2	31.7	23.9	3.6	360
30		50	0	1014.4	27.2	22.8	4.1	320

[1] See keynotes.

Table B-5. Meteorological observations, July 1978.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Amount of precipitation	Atmospheric pressure	Temperature (°C)		Land	
		Type	Inten.	(pct)	(mm)	(mb)	High	Low	Wind-speed (m/s)	Wind direction (true N.)
3	0700	TH		100	1	1011.1	24.4	21.1	2.1	50
5	0700			100	3	1018.5	24.4	19.4	4.6	50
6	0700			0	0	1023.2	22.2	18.3	3.1	50
7	0700			0	0	1023.2	24.4	20.0	2.1	90
10	0700	K		0	0	1016.5	32.2	23.9	4.6	230
11	0700			100	0	1014.8	33.9	21.1	0	
12	0700			50	24	1019.9	24.4	20.0	7.2	50
13	0700			50	0	1022.6	24.4	17.8	1.0	50
14	0700			100	0	1020.5	25.0	20.0	3.1	230
17	0700			100	12	1011.1	24.4	21.1	3.1	320
18	0700	F	(-)	0	0	1019.9	26.7	20.6	2.1	130
19	0700			50	0	1024.6	28.3	22.8	2.6	50
20	0700			50	8	1021.9	27.2	23.3	5.1	50
21	0700			50	18	1021.9	27.2	23.9	2.1	320
24	0700			50	0	1019.9	33.9	26.1	2.6	230
25	0700			50	0	1019.5	32.2	22.2	2.1	50
26	0700			100	22	1015.1	28.9	22.2	3.1	50
27	0800			50	0	1015.8	27.2	23.3	4.1	230
28	0700			50	0	1015.1	31.7	25.0	2.1	50
31	0700			50	0	1015.1	33.3	26.1	5.7	230

[1] See keynotes.

Table B-6. Meteorological observations, August 1978.

Day (time 0700)	Prevailing weather conditions[1]		Cloud cover	Amount of precipitation	Atmospheric pressure	Temperature (°C)		Land	
	Type	Inten.	(pct)	(mm)	(mb)	High	Low	Wind-speed (m/s)	Wind direction (true N.)
1			50	0	1016.5	32.2	25.6	4.1	230
2	TH		100	18	1021.2	30.6	22.2	2.1	130
3			50	1	1021.9	27.8	22.2	2.3	130
4			50	0	1021.6	30.0	21.7	1.5	130
7			50	0	1025.3	31.7	22.8	2.3	130
8			0	7	1025.3	30.6	25.6	2.3	230
9			50	0	1022.6	28.9	21.7	3.1	230
10			100	0	1020.2	31.1	22.2	3.1	320
11			100	0	1018.8	30.6	24.4	4.6	250
14	F		0	0	1019.9	28.9	20.0	1.0	50
15	K		0	0	1021.2	27.2	23.3	1.5	110
16	K	(-)	0	0	1018.8	30.0	25.0	3.6	230
17			0	0	1016.1	31.1	27.2	3.1	230
18	K	(-)	0	0	1015.8	33.9	24.4	2.3	50
21				0	1019.9	30.6	22.2		
22			100	0	1021.9	26.1	22.8	4.1	360
23			50	0	1021.9	28.3	19.4	2.1	340
24			0	0	1021.9	27.8	18.9	2.3	270
25	K		0	0	1016.8	30.0	23.3	5.1	230
28			50	2	1018.8	27.8	22.8	4.1	200
29	K		0	0	1015.1	30.6	25.0	4.1	200
30			100	0	1017.8	33.9	25.6	2.1	230
31			100	0	1019.2	32.2	25.6	4.1	200

[1] See keynotes.

Table B-7. Meteorological observations, September 1978.

Day (time 0700)	Prevailing weather conditions[1] Type	Cloud cover (pct)	Amount of precipitation (mm)	Atmospheric pressure (mb)	Temperature (°C) High	Temperature (°C) Low	Land Wind-speed (m/s)	Land Wind direction (true N.)
1		50	4	1019.2	31.7	24.4	4.1	230
2		50	0	1020.5	27.8	22.8	3.6	50
3		0	0	1015.8	27.2	22.2	3.1	360
4	K	0	1	1013.4	27.8	21.1	4.1	360
5	K	0	0	1017.5	27.8	18.3	2.1	320
8	K	0	0	1014.4	31.1	22.8	2.1	360
11		20	0	1020.9	26.1	20.0	1.5	130
12	K	0	0	1016.1	28.9	19.4	1.5	20
13	K	90	0	1013.1	29.4	19.4	1.5	50
14		50	4	1021.9	27.2	20.6	5.1	50
15			0	1020.5	23.3	21.1	1.5	130
18	K	0	0	1020.5	27.8	23.3	2.6	230
19		20	0	1019.2	32.2	24.4	4.1	270
20		100	5	1019.9	33.9	21.1	6.7	20
21			0	1020.2	23.3	21.1	2.6	50
22		80	0	1021.9	26.7	20.6	3.1	230
25		20	0	1019.2	22.2	15.6	2.6	340
26		0	0	1023.6	23.3	18.3	6.7	50
27		100	0	1022.6	22.2	17.8	6.2	50
28		0	0	1016.1	21.1	16.1	2.6	340
29		30	0	1022.6	25.0	16.7	6.2	50

[1]See keynotes.

Table B-8. Meteorological observations, October 1978.

Day	Time	Prevailing weather conditions[1] Type	Cloud cover (pct) (pct)	Visibility (km) (km)	Amount of precipitation (mm)	Atmospheric pressure (mb)	Pressure trends[1]	Temperature (°C) High	Temperature (°C) Low	Land Wind-speed (m/s)	Land Wind direction (true N.)
2	0700		100		13	1014.1		23.3	18.9	7.2	360
3	0700		0	14	0	1018.5	203	21.1	16.7	3.1	20
4	0700		0	8	0	1018.2	502	21.1		2.1	130
5	0710	K	0	6	0	1018.2	302	23.3	17.8	3.6	50
6	0705	K	0	3	0	1011.7	400	23.9	18.9	2.6	230
10	0710		25	14	0	1028.7	401	16.7	5.0	2.1	320
11	0710		25	14	0	1022.6	400	18.9	12.2	4.1	70
12	0718	K	0	5	0	1018.8	203	21.1	14.4	0.0	
13	0715	K	30	5	0	1019.2	400	23.9	14.4	2.1	160
16	0715		30	14	0	1020.9	303	16.1	3.9	2.6	230
17	0720	TH	100	8	9	1021.2	306	17.8	11.7	3.1	340
18	0710		10	14	4	1030.0	304	15.6	12.2	5.1	20
19	0710		10	14	0	1021.6	703	16.7	10.6	4.1	230
20	0710		10	14	0	1014.8	305	19.4	11.7	3.1	320
23	0705		0	14	0	1020.5	601	22.8	15.0	3.6	230
24	0705	K	100	5	2	1019.2	206	24.4	11.7	8.8	20
25	0700		0	14	0	1021.9	204	15.6	9.4	4.1	90
26	0705		0	14	0	1019.2	202	19.4	15.0	2.6	200
27	0705		100	14	0	1015.8	205	25.6	17.2	2.6	290
30	0730		25	14	0	1030.0	105	16.7	14.4	6.7	20
31	0730		100	8	0	1026.6	702	16.7	15.0	6.2	20

[1]See keynotes.

Table B-9. Meteorological observations, November 1978.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)		Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Wind-speed (m/s)	Wind direction (true N.)
1	0730	K		0	8	0	1021.2	203	17.8	10.0	3.6	320
2	0730	K		0	14	0	1023.2	302	18.3	11.7	4.6	40
3	0730	K		25	14	0	1023.2	302	18.3	13.9	5.1	30
6	0735	K		10	6	56	1021.2	204	18.3	13.3	1.0	250
7	0735	K		0	8	0	1017.8	400	18.9	13.9	2.1	220
8	0730	R		100	6	4	1014.4	400	22.8	15.0	5.7	30
9	0735	K		100	6	18	1020.2	205	18.9	12.2	3.1	350
13	0745	K	(-)	100	8	2	1027.6	206	16.1	14.4	5.1	60
14	0730	K	(-)	0	8	0	1026.6	202	16.7	14.4	0.0	
15	0735	K		100	8	0	1024.6	202	19.4	15.6	2.1	220
16	0740	K		90	8	0	1025.3	202	21.1		1.5	220
17	0735	K		75	6	0	1027.6	500	18.9	15.6	4.1	100
20	0740			100	6	0	1031.0	304	13.3	11.7	5.1	40
21	0735			25	14	0	1028.6	400	15.6	12.8	5.1	40
22	0730			50	8	0	1025.3	202	16.7	12.8	5.7	30
24	0740	K		100	5	8	1008.3	501	15.0	12.2	4.1	270
27	0730			100	8	0	1018.5	603	12.2	4.4	6.2	150
28	0740	K		100	6	12	1016.1	102	19.4	12.2	3.1	180
29	0730	K		100	6	0	1025.9	102	16.7	10.6	4.1	70
30	0745	K	(-)	100	6	28	1016.5	104	17.2	9.4	3.1	280

[1] See keynotes.

Table B-10. Meteorological observations, December 1978.

Day (time 0730)	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)		Land	
	Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Wind-speed (m/s)	Wind direction (true N.)
1	K	(-)	100	8	0	1016.5	104	12.8	9.4	7.7	30
4			25	8	0	1011.4	702	18.3	6.1	6.2	200
5			100	8	4	1007.7	206	22.8	12.8	2.1	10
6			0	14	18	1019.8	205	13.9	8.9	2.1	250
7			0	14	0	1026.6	303	16.1	5.0		
8	K	(-)	25	8	0	1023.9	400	17.8	13.9	3.6	200
11			100	8	7	1031.7	003	4.4	0.0	5.7	30
12			30	8	0	1027.6	000	6.1	3.9	7.7	20
13			30	14	0	1026.6	000	8.9	3.3	2.1	200
14			100	14	0	1021.9	208	12.8	4.4	3.6	320
15			10	14	0	1027.3	105	7.8	3.3	5.1	220
18			60	14	4	1023.9	203	9.4	3.9	4.1	320
19			100	8	0	1016.1	205	14.4	4.4	4.1	340
20			100	11	0	1015.4	601	8.9	5.0	3.6	110
21			100	11	2	997.5	302	15.0	8.9	6.2	200
22			0	14	1	1019.2	208	15.0	2.8	3.1	360
26			0	14	48	1020.9	304	11.1	3.9	2.6	240
27			10	14	0	1022.2	209	12.8	3.3	6.7	350
28			30	14	0	1029.3	303	6.1	-1.1	7.7	30
29			10	14	0	1033.0	500	2.8	0.0	5.1	40

[1] See keynotes.

Table B-11. Meteorological observations, January 1979.

Day (time 0730)	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)				Land			
	Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Wind-speed (m/s)	Wind direction (true N.)	WFG[1]	VAR[1]
2			75	8	0	1013.4	707	18.9	13.3			6.2	170		
3			25	16	60	1026.6	247	19.4	-3.9			7.2	290		
4			10	24	0	1038.1	210	-1.8	-5.6	-1.8	2.0	4.1	250		
5			100	8	0	1038.5	203	2.2	-1.8	1.7	0.5	2.1	290		
8	R/F	(-)	100	8	28	1029.3	307	16.7	12.2	12.2	12.1	5.1	170		
9			25	24	1	1027.7	227	14.4	-1.8	-1.7	-1.3	4.1	350		
10			0	16	0	1029.3	203	2.2	-3.3	0.0	-0.1		320		
11			10	24	0	1031.4	207	5.6	-2.2	0.6	1.5	2.1	330		
12	R	(-)	100	13	0	1027.7	000	6.7	0.6	6.1	6.0	7.2	50		
15			25	24	53	1030.7	220	11.1	-1.1			4.1	320		
16			25	24	0	1033.4	707	3.3	-5.6	1.7	1.0	2.1	180		
17			25	24	0	1030.0	500	7.2	-2.2	2.8	3.3	2.1	180		
18			0	24	0	1015.1	320	11.1	2.8	8.3	7.0	5.7	290		
19			90	24	0	1030.0	314	10.6	-3.9	-2.2	-2.0	5.7	10		
22			90	24	19	1005.6	241	15.0	5.6	5.6	4.0	6.2	250		
23			10	24	0	1021.9	317	9.4	2.8	5.0	5.0	3.6	60		
24			100	14	9	1001.6	641	15.0	4.4			5.1	160		
25	R		10	24	3	1000.2	230	19.4	0.0	0.6	0.0	6.2	240	(+)	11
26			10	24	0	1005.0	214	6.1	0.0	0.6	0.0	5.7	290		
29			25	24	7	1005.0	220	5.6	1.7	1.7	1.0	7.7	260		
30			0	24	0	1012.4	217	9.4	-0.6	-0.6	-1.0	7.2	300		
31	S	(-)	100	16	0	1009.4	803	8.3	-0.6	0.0	1.0	2.1	330		

[1] See keynotes.

Table B-12. Meteorological observations, February 1979.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)				Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Wind-speed (m/s)	Wind direction (true N.)
1	0730			0	24	0	1007.0	317	3.9	-2.2	-1.7	-3.5	6.2	290
5	0730			75	24	0	1018.8	030	11.1	1.1	1.1	-1.0	4.1	360
6	0730			40	24	0	1024.9	217	2.8	-2.8	-1.7	-2.0	7.2	20
7	0800	RS		100		8	1005.6	768	4.4	-5.6	4.4	6.0	11.3	100
8	0730			10	24	2	1016.8	244	8.9	-1.1	-0.6	-0.5	4.1	270
9	0730			90		0	1015.1	707	6.7	-0.6	0.6	2.0	1.5	230
12	0730			60	24	0	1028.7	000	-2.2	-5.6	-2.2	-3.0	4.1	120
13	0800			75	16	0	1023.2	237	5.6	-4.4			9.3	360
14	0730			75	24	0	1026.6	303	-2.8	-5.6			5.1	360
15	0730			100	16	0	1015.8	400	3.3	-4.4	3.3	2.5	3.6	220
16	0730	F		100		0	1012.8	217	6.1	1.7	1.7	2.0	2.1	320
20	0730			0	24	19	1028.0	320	3.9	-3.3	0.0	0.0	2.1	30
21	0730	F		100		0	1029.3	603	5.0	-1.1	3.9	4.0	3.6	160
22	0730	F	(+)	100		3	1026.3	314	14.4	3.3	7.8	8.5	0.0	
26	0730			25	24	61	1005.0	234	18.3	3.3			4.1	210
27	0730			0	24	0	1013.1	227	11.7	2.2	3.3	2.5	4.6	260
28	0730			10	24	0	1022.9	217	6.7	0.0				

[1] See keynotes.

Table B-13. Meteorological observations, March 1979.

Day (time 0730)	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)				Land	
	Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Wind-speed (m/s)	Wind direction (true N.)
1			10	16	0	1023.9	500	6.7	0.6			1.0	30
2	F	(+)	100	0	8	1025.3	220	7.2	3.9			1.0	10
5			100	16	0	1023.9	210	15.6	6.1			3.1	170
6			100	16	4	1017.5	703	19.4	8.3			3.6	180
7			100	16	23	1014.1	207	17.2	4.4			4.1	20
8	F	(+)	100	0	0	1011.7	307	6.7	0.0			0.0	
9			10	16	0	1020.9	244	8.3	0.0			2.1	320
12			0	24	11	1021.9	234	7.2	1.1			6.2	310
13			0	24	0	1029.7	220	10.6	2.2	9.5	7.0	3.6	180
14			100	16	0	1016.8	720	17.2	9.4	14.5	12.5	6.2	170
15			75	16	3	1020.2	234	16.7	2.8	6.0	5.0	7.7	360
16			10	24	0	1036.8	227	5.6	-0.6	1.0	0.0	5.7	360
19			0	24	0	1024.3	310	12.2	5.6	6.5	5.0	3.6	20
20			0	24	0	1019.5	310	8.9	2.2	7.0	5.0	3.6	290
21			0	24	0	1019.2	227	9.4	4.4	8.0	6.0	5.4	10
22			0	24	0	1023.9	320	10.6	4.4	8.5	8.0	4.1	20
23	F	(-)	0	16	0	1018.8	033	10.6	6.1	9.3	9.0	2.6	110
26			0	24	15	1014.1	234	19.4	5.6	8.0	5.0	5.7	330
27			0	24	0	1025.3	237	12.8	5.6	7.2	6.0	5.4	40
28			0	16	0	1030.7	222	7.8	3.3	8.0	6.0	6.7	40
29	RS	(-)	8	10	0	1030.7	217	13.3	6.7	14.0	13.0	3.6	220
30			1	16	0	1028.7	214	22.2	13.3	16.0	14.0	7.2	220

[1] See keynotes.

Table B-14. Meteorological observations, April 1979.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)				Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Wind-speed (m/s)	Wind direction (true N.)
2	0730			75	10	0	1019.5	214	25.6	12.2			6.2	220
3	0730	RS	(-)	100	10	0	1019.9	210	25.6	17.8	19.0	18.0	7.2	220
4	0730	RS	(-)	100	2	18	1018.8	803	22.2	9.4	10.0	10.0	4.6	70
5	0730			75	16	3	1047.6	224	18.9	9.4	15.0	13.5	4.1	270
6	0730			0	24	0	1015.8	200	17.2	8.9	15.0	10.0	6.7	230
9	0730	R/TH	(-)	100	10	0	1001.6	741	18.3	11.7	20.0	18.0	9.3	200
10	0730			10	24	11	1015.1	791	20.6	6.7	8.5	6.0	5.7	340
11	0730			10	10	0	1027.3	220	11.7	7.2	11.5	10.0	3.1	140
12	0730			10	10	0	1024.9	707	15.0	10.0	13.0	12.0	2.6	190
13	0730	R		75	3	0	1016.1	203	21.7	13.9	19.0	18.0	2.1	140
16	0730			0	24	21	1015.2	224	18.3	11.7	11.0	7.5	5.7	320
17	0730			10	24	0	1019.9	220	13.9	7.2	10.0	7.0	5.1	310
18	0730			0	16	0	1022.6	214	12.8	5.0	12.0	8.0	5.1	330
19	0730			0	24	0	1023.2	217	14.4	7.8	12.0	8.0	6.2	360
20	0730			10	24	0	1023.9	217	13.9	7.2	11.5	9.0	6.2	20
23	0730			90	16	0	1024.9	203	23.3	16.1	19.5	17.0	5.7	250
24	0730	F	(-)	100	8	0	1026.0	203	23.9	12.2	14.0	13.0	3.1	140
25	0730			30	10	0	1022.6	400	16.1	12.8	15.0	14.0	2.1	130
26	0730	R		100	8	0	1013.4	707	18.9	15.0	15.5	15.0	6.2	140
27	0730			100	16	16	1002.6	403	20.6	11.7	20.0	18.5	5.1	210
30	0630			0	16	3	1019.9	400	14.4	7.2	13.3	12.0	1.5	90

[1] See keynotes.

Table B-15. Meteorological observations, May 1979.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed (m/s)	Wind direction (true N.)
1	0630			10	16	0	1019.9	210	17.8	10.6	16.0	15.0	14	3.1	210
2	0630			10	24	0	1025.3	217	17.8	12.2	14.0	12.0	11	4.1	50
3	0630	K	(-)	10	10	0	1023.6	207	17.8	11.1	17.0	15.0	14	1.5	170
4	0630			10	16	0	1015.5	203	24.4	16.1	21.0	19.5	18	7.2	230
7	0630			0	16	8	1021.6	217	15.6	13.3	16.5	14.0	12	2.1	170
8	0630			0	16	0	1021.9	210	21.1	13.9	17.0	16.0	15	2.6	130
9	0630	K	(-)	10	8	0	1021.9	207	22.2	12.8	18.0	18.0	18	2.6	150
10	1530			90	16	1	1017.2	710	26.1	17.8	25.0	22.0	21	6.7	220
11	0630	K	(-)	100	10	9	1013.8	303	26.7	16.7	21.5	21.0	21	3.1	290
14	0630	R		100	5	76	1015.8	303	27.8	15.6	18.0	18.0	18	2.1	140
15	0630	R		100	5	77	1019.9	210	18.3	14.4	16.3	16.0	16	3.6	360
16	0630	F		100	2	0	1021.6	210	19.4	14.4	16.0	16.0	16	4.6	10
17	0630			0	16	0	1024.3	210	20.6	15.6	17.0	14.0	12	8.2	40
18	0630	RS		100	5	0	1020.5	500	19.4	14.4	15.0	14.5	14	7.7	20
21	0630			100	8	53	1015.1	207	17.2	14.4	15.0	15.0	15	2.1	20
23	0630			100	16	0	1018.8	503	22.2	17.2	23.0	21.0	20	4.6	180
24	0630			100	16	0	1011.7	707	27.8	18.3	23.0	22.0	22	6.2	190
25	0630			100	16	11	1003.3	207	24.4	19.4	21.0	20.0	20	3.6	220
29	0630	RS	(-)	100	8	1	1015.1	217	26.7	17.2	18.0	17.0	16	2.1	120
30	0630			30	8	1	1016.5	224	23.9	15.0	20.0	18.5	17	5.1	260
31	0630			25	16	0	1021.9	214	24.4	20.0	22.5	22.0	22	5.1	200

[1] See keynotes.

Table B-16. Meteorological observations, June 1979.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed (m/s)	Wind direction (true N.)
1	0630			100	8	7	1019.2	500	29.4	20.0	23.0	22.0	22	6.2	220
2	0630			100	2	4	1016.8	207	27.8	17.2	18.0	18.0	18	3.1	360
4	0700	RS		100	5	32	1008.4	000	22.2	20.0				4.1	40
5	0630			0	16	0	1010.7	214	22.8	17.2				1.5	130
6	0630			0	16	0	1015.1	220	23.3	17.8	23.5	21.0	20	2.1	220
7	0630			0	16	0	1019.2	307	28.3	21.1	24.0	21.5	20	2.1	210
8	0630	F		100	2	0	1023.2	207	28.3	18.9	20.5	20.0	20	2.1	130
11	0630	K		100	8	0	1010.7	707	26.7	19.4	25.0	22.0	21	5.1	200
12	0630			0	24	4	1016.8	224	27.2	15.0	19.5	16.0	14	5.1	10
13	0630			0	24	0	1022.6	314	22.2	13.9					
14	0630			0	24	0	1027.3	217	23.9	18.9	21.0	16.5	13	6.2	50
15	0630			0	24	0	1027.7	000	21.7	18.3	20.5	17.0	15	4.1	50
18	0630			0	24	5	1013.8	214	27.2	18.3	19.5	18.0	17	6.7	260
19	0630			30	16	0	1019.5	224	28.9	18.3	22.0	19.0	17	5.1	20
20	0630			10	16	0	1026.3	210	23.3	18.3	20.5	17.0	15	8.8	30
21	0630			10	24	0	1027.0	400	22.8	15.0	20.5	16.0	13	2.6	300
22	0630	RS	(-)	100	10	0	1019.5	500	24.4	17.8	21.5	20.0	19	4.1	220
25	0630			100	24	19	1021.6	224	29.4	16.7	18.5	15.5	13	8.8	20
26	0630			75	24	0	1028.7	214	20.6	17.8	20.0	16.0	14	7.7	70
27	0630			75	16	0	1027.3	707	22.2	18.9	20.0	18.0	17	8.8	50
28	0630			30	24	0	1021.9	400	22.8	19.4	21.5	18.0	16	6.2	30
29	0630			50	16	0	1019.9	214	23.9	14.4	20.0	19.0	19	2.6	250

[1] See keynotes.

Table B-17. Meteorological observations, July 1979.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed (m/s)	Wind direction (true N.)
2	1300			30	16	0	1013.1	112	30.6	18.9				3.6	290
3	1400			30	16	0	1016.5	400	26.1	20.6	27.0	21.0	18	3.1	60
5	1100			25	16	18	1017.8	206		18.3	20.5	18.0	17	4.1	360
6	1130			25	16	0	1027.7	205	23.9	17.2	20.1	17.9	17	5.1	30
9	1230			50	16	0	1023.2	400	26.7	12.8	25.2	21.1	20	4.6	11
10	1300			60	16	0	1017.8	400	26.7	21.1	24.8	23.8	22	2.1	7
11	1200			30	16	2	1017.8	204	26.1	17.2	25.0	23.2	22	2.1	11
12	1345				16	0	1018.8	400	31.7	16.7	31.1	26.1	24	4.1	23
16	1400				13	0	1015.8	400	33.3	15.6	28.0	26.0	25	5.7	50
17	0630	K	(-)	60	8	0	1017.8	217	27.8	24.4	26.5	27.5	23	4.1	360
18	0630	K	(-)	100	8	0	1018.5	217	28.9	23.3	26.5	25.0	24	1.5	180
19	0630	R	(-)	100	8	11	1019.2	207	28.9	22.2	25.5	24.0	23	3.1	120
20	0630	K	(-)	75	8	17	1021.2	214	25.0	21.1	25.5	23.5	22	3.1	20
23	0630			100	24	7	1024.6	220	28.9	25.0	26.0	24.5	23	4.1	240
24	0630			25	24	1	1024.6	207	29.4	25.0	27.0	25.0	24	4.1	240
25	0630			90	16	1	1021.9	500	32.2	25.6	26.0	25.0	25	4.6	230
26	0630			100	16	0	1017.8	207	31.1	25.6	26.5	24.5	23	4.1	230
27	0630	K	(-)	90	13	3	1014.4	214	31.1	25.0	26.5	25.0	24	4.1	270
30	0630			50	24	9	1012.8	307	32.2	25.0	26.0	23.0	25	0.0	
31	0630			100	25	0	1016.1	217	30.0	24.4	24.5	24.0	24	2.1	330

[1] See keynotes.

Table B-18. Meteorological observations, August 1979.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed (m/s)	Wind direction (true N.)
1	0630	K	(-)	75	8	0	1016.1	207	31.7	23.9	29.0	26.0	25	3.1	270
2	0630	K	(-)	75	8	0	1015.8	217	32.2	26.1	28.0	26.0	25	3.6	210
3	0630	K	(-)	30	8	0	1015.5	214	34.4	23.3	25.0	24.0	24	3.6	160
6	0630	K	(-)	30	8	0	1017.2	210			28.0	24.0	24	2.1	230
7	0630	K	(-)	30	8	0	1017.2	214	33.9	26.1	28.0	25.0	24	2.1	40
8	0630	K	(-)	50	8	0	1019.2	500	30.6	23.9	28.0	25.0	24	4.6	230
9	0630	K	(-)	50	16	2	1019.2	214	34.4	22.2	25.0	23.0	22	4.1	310
10	0830	K	(-)	30	16	0	1018.8	400	30.6	23.3	31.0	27.0	26	3.6	240
13	0630			100	16	29	1017.8	227	29.4	17.8	19.0	17.0	16	4.1	310
14	0630			0	24	0	1022.2	203	26.1	19.4	22.0	20.0	19	5.7	220
15	0630			100	16	0	1017.8	307	29.4	21.1	22.0	20.0	19	5.7	310
16	0630			50	16	0	1022.6	217	25.0	18.3	19.5	16.0	14	7.2	360
17	0630			30	24	0	1024.9	210	22.8	16.7	20.0	17.5	16	4.1	310
20	0630			100	16	0	1016.8	400	30.0	22.2	23.0	23.0	23	1.5	50
21	0630	K	(-)	100	8	0	1017.8	207	28.3	20.0	23.5	23.0	23	1.5	90
22	0630			100	8	15	1016.1	210	29.4	20.0	22.5	22.0	22	4.6	50
23	0630			100	8	2	1018.5	214	26.7	21.7	24.5	23.0	22	4.1	50
24	0630			0	16	0	1018.8	210	28.3	22.8	27.0	25.0	24	3.6	160
27	0630			30	16	0	1020.9	500	30.0	25.6	27.5	25.0	24	3.6	200
28	0630	K	(-)	25	16	0	1017.2	500	31.7	21.7	25.0	24.0	24	4.1	210
29	0630			30	24	2	1017.5	214	28.9	21.7	24.5	23.5	23	1.5	130
30	0630			10	16	0	1015.8	307	30.0	22.2	27.0	25.0	24	3.6	260
31	0630			30	16	0	1016.5	214	31.7	22.2	24.5	24.0	24	1.5	360

[1] See keynotes.

Table B-19. Meteorological observations, September 1979.

Day (time 0730)	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
	Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed (m/s)	Wind direction (true N.)
4	K	(-)	100	8	22	1017.2	207	31.1	23.3	23.0	23.0	23	2.1	70
5			100	5	24	1015.8	400	25.6	21.1	23.0	22.0	22	6.2	140
6			100	8	24	1009.7	307	27.8	21.1	25.0	24.0	24	6.2	200
7	K	(-)	10	8	0	1009.4	500	31.1	23.3	25.0	23.0	22	3.6	270
10	K	(-)	60	8	0	1021.2	400	23.3	21.7	20.0	20.0	19	7.7	40
11			0	24	2	1018.8	203	25.0	19.4	23.5	20.5	19	5.1	40
12			0	24	0	1020.5	210	25.6	23.3	25.0	23.0	22	5.1	50
13			30	16	0	1019.9	307	25.6	22.2	23.5	22.5	22	5.1	70
14			90	16	0	1011.7	707	27.8	22.8	25.5	24.5	24	8.8	180
17			100	8	4	1024.6	500	22.2	20.6	20.0	18.0	17	4.6	50
18			100	16	0	1020.2	400	22.8	20.6	21.5	19.5	18	4.6	20
19	K	(-)	0	8	0	1013.8	400	23.9	14.4	20.5	19.0	18	5.1	270
20			0	24	0	1021.6	220	26.7	19.4	21.0	17.5	16	6.7	60
21			100	24	0	1020.5	400	23.3	19.4	22.5	21.0	20	3.6	150
24	RS	(-)	100	8	39	1020.5	217	21.7	20.0	21.0	19.5	18	7.2	360
25			100	8	32	1019.5	400	21.1	19.4	21.5	21.0	21	6.7	360
26			100	8	0	1021.9	214	23.9	19.4	20.0	19.0	19	6.2	360
27			0	24	0	1022.2	400	22.2	18.3	21.0	19.0	18	6.2	360
28			90	16	0	1020.2	500	24.4	20.0	22.0	21.0	21		50

[1]See keynotes.

Table B-20. Meteorological observations, October 1979.

Day	Time	Prevailing weather conditions[1]		Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
		Type	Inten.	(pct)	(km)	(mm)	(mb)		High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed (m/s)	Wind direction (true N.)
1	0630			30	16	32	1013.1	207	23.3	22.8	22.0	21.0	21	6.2	190
2	0630	K	(-)	0	16	0	1009.7	207	26.1	21.1	22.0	21.5	21	4.1	200
3	0630	TH		100	8	3	1009.0	310	28.3	22.2	22.5	21.0	20	6.7	200
4	0630			0	24	0	1016.1	303	23.9	15.0	18.5	17.0	16	2.1	200
5	0630			100	16	0	1009.4	717	26.1	16.7	21.0	20.0	20	4.1	120
8	0630			0	24	0	1016.5	214	22.2	13.3	14.0	10.0	6	6.2	240
9	0630			0	24	0	1015.1	000	18.3	12.2	21.0	19.0	18	6.2	180
11	0630			100	16	0	1014.4	203	12.2	6.7	9.0	8.0	7	4.6	280
12	0630			0	24	0	1012.4	207	15.0	8.3	18.5	15.0	13	5.1	200
15	0630			0	24	8	1026.0	210	14.4	9.4	10.0	9.0	8	3.1	240
16	0630			0	8	0	1022.9	303	17.2	7.8	13.0	12.0	11	1.5	200
17	0630			25	8	0	1024.6	214	21.1	7.8	10.5	10.0	10	1.5	140
18	0630	K		0	5	0	1025.3	307	21.1	8.9	17.5	17.0	17	3.1	60
19	0630	K		0	5	15	1024.3	303	21.1	16.1	18.0	17.5	17	4.1	50
22	0630	K		0	5	0	1022.6	400	26.7	17.8	21.0	19.5	18	2.1	220
23	0630	K		0	8	0	1015.5	707	26.1	15.0	20.0	19.0	19	2.1	220
24	0630			25	8	8	1009.7	220	25.6	11.1	12.5	11.0	10	6.7	290
25	0630			30	16	0	1015.8	220	14.4	7.8				8.2	280
26	0630			50	16	0	1018.2	214	13.9	5.6	10.0	9.0	8	3.1	270
29	0730			0	24	0	1015.8	224	17.8	9.4	16.0	14.0	13	4.1	320
31	0730			10	16	0	1027.7	207	16.7	13.3	17.0	14.0	12	7.2	360

[1]See keynotes.

Table B-21. Meteorological observations, November 1979.

Day	Time	Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
							High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed	Wind direction
		(pct)	(km)	(mm)	(mb)							(m/s)	(true N.)
1	0730	30	16	0	1027.3	303	18.3	15.0	18.0	16.0	15	7.2	90
2	0730	60	16	0	1021.2	507	21.1	14.4	18.0	17.0	16	4.1	130
5	0730	75	24	45	1030.7	320	12.2	10.6	13.0	10.0	7	7.2	50
6	0730	25	24	0	1026.0	603	15.6	11.7	16.0	14.0	13	3.6	90
7	0730	0	24	0	1019.9	307	20.0	7.2	11.0	9.0	6	4.1	320
8	0730	10	16	0	1020.9	314	16.7	6.1	10.0	9.0	8	2.6	360
9	0730	50	16	0	1017.5	503	17.2	5.0	14.0	13.0	12	3.6	130
13	0730	100	6	27	1014.1	500	13.9	11.7	16.0	15.5	15	5.1	50
14	0730	100	13	2	1016.5	224	15.6	7.8	9.5	7.0	4	7.2	320
15	0730	10	16	0	1025.6	114	11.7	3.3	5.5	3.5	2	3.6	320
16	0730	75	24	0	1018.5	107	11.1	4.4	10.0	7.0	5	4.1	250
19	1450	0	24	0	1024.3	102	20.0	-2.2	18.5	16.0	15	1.5	130
21	1200	0	24	0	1029.7	000	16.7	8.9	15.8	15.8	15	1.5	50
23	0730	10	24	0	1024.6	207	22.8	6.1	17.0	16.5	16	4.1	180
27	0730	10	24	46	1024.6	220	24.4	11.7				2.6	250
28	0730	90	16	0	1018.2	710	19.4	11.7	15.0	14.0	14	4.1	200
29	0730	10	24	0	1014.8	214	21.1	6.7	7.5	6.0	4	5.7	320
30	0730	10	24	0	1022.2	320	10.6	-0.6				4.6	320

[1] See keynotes.

Table B-22. Meteorological observations, December 1979.

Day	Time	Prevailing weather conditions[1]	Cloud cover	Visibility	Amount of precipitation	Atmospheric pressure	Pressure trends[1]	Temperature (°C)					Land	
		Type						High	Low	Dry bulb	Wet bulb	Dew point	Wind-speed	Wind direction
			(pct)	(km)	(mm)	(mb)							(m/s)	(true N.)
3	0730		30	24	0	1034.8	114	10.0	-1.1	-0.5	-1.0	-3	5.1	320
4	0730		10	24	0	1025.6	614	6.1	-2.2	2.8	2.0	1	5.1	200
5	0730		10	24	0	1019.9	400	10.0	1.7	4.5	4.0	3	2.1	200
6	0730		90	19	0	1014.8	001	15.6	3.9	11.6	10.5	9	3.1	200
7	0730		100	13	17	1011.4	234	16.7	11.1	12.2	11.5	11	2.6	320
10	0730		25	16	1	1027.7	500	13.9	1.7	6.1	5.5	4	3.1	230
11	0730		10	24	0	1028.0	214	13.3	5.6	6.1	5.0	4	1.5	200
12	0730		10	16	0	1027.0	301	16.7	5.0	8.9	8.0	7	3.1	200
13	0730		50	16	0	1022.9	000	19.4	8.3	13.9	13.0	12	3.6	200
14	0730		100	16	17	1024.9	234	19.4	7.8				9.3	20
17	0730		75	16	1	1019.9	258	14.4	2.8	2.8	1.0	-2	10.3	340
18	0730		60	16	0	1030.0	117	2.8	-3.3	-2.8	-4.0	-7	3.1	340
19	0730		75	24	0	1024.3	000	3.3	1.7	2.6	2.0	1	1.0	230
20	0730		50	24	0	1024.6	324	9.4	1.7	9.4	7.5	4	6.2	20
21	0730		50	8	3	1029.7	107	10.6	7.2	8.4	7.0	6	6.2	50
22	0730	F	100	8	0	1026.0	303	11.1	6.1	7.8	8.0	8	3.1	20
26	0830		100	24	11	1010.7	241			6.7	6.0	5	4.1	320
27	0800		100	24	0	1019.5	217	11.1	2.2	3.9	4.0	3	1.0	320
28	0800		0	24	0	1025.3	217	9.4	2.2	6.5	4.0	1	2.6	320

[1] See keynotes.

APPENDIX C

1979 SEDIMENT SURVEY

This appendix contains the most recent detailed sediment survey data for the FRF, collected by CERC divers in August 1979. A summary of the data is provided by Allan E. DeWall, CERC Coastal Processes and Structures Branch. Keynotes on the bed-form descriptions and RSA analysis of the samples are as follows:

Sample No. - Corresponds to number on sample bag.

Range - Distance north or south (in meters) from pier.

Distance - Distance offshore (east, in meters) from FRF base line.

Depth - Leadline depth (in meters) below SWL (not corrected for tide).

Date-Time - First number is day in August 1979 (7, 8, or 9); second number is eastern daylight time (e.d.t.) or commonly called daylight savings time.

Description - Visual observation of bottom at time sample was taken.

Symbols - λ = ripple wavelength

α = ripple height

κ = magnetic azimuth of ripple crest (350° is approximately shore parallel).

SUMMARY OF SEDIMENT SAMPLING AND BED-FORM DESCRIPTION IN THE NEARSHORE REGION OF THE FIELD RESEARCH FACILITY

by

Allan E. DeWall

On 7-9 August 1979, a set of short core samples and visual bed-form descriptions were collected along four nearshore range lines in the vicinity of the CERC pier at Duck, North Carolina (Fig. C-1). Range I was along the pier centerline, range II was 76 meters north, range III was 76 meters south, and range V was 305 meters south of the pier. A fifth line--range IV, located 305 meters north of the pier--was planned but time did not allow for sampling.

Using profile data collected in September 1978, stations were preselected at 2-meter-depth increments and at breaks in slope extending from a depth of approximately 3 meters to a maximum depth of 15.8 meters which occurred at the Waverider buoy 3.3 kilometers offshore. Samples and bed-form descriptions were collected by a team of two divers working from a Zodiac inflatable boat. Positioning was accomplished using a Motorola "Mini-Ranger," coupled to a Hewlett-Packard Mini-Computer and flatbed plotter. This positioning system was put together and operated by Frank Musialowski, CERC Geotechnical Engineering Branch. The real-time plotting capability allowed for the immediate reduction and display of sampling position as well as a great deal of flexibility in modifying the sampling plan.

Samples were collected using a hand-held piston corer 3.2 centimeters in diameter and approximately 40 centimeters long. The core was extruded directly into a prelabeled sample bag and no attempt was made to differentiate laminations within the core. While one diver collected the sample, the second diver recorded conditions on the bottom. This description included sediment type; presence of bed forms; ripple height, wavelength, and orientation; and degree of bioactivity.

Visibility on the bottom ranged from 0 to 3 meters. A thermocline was encountered at approximately 7.5 meters below the surface. Water temperature on the surface was approximately 27° Celsius (80° Fahrenheit) and dropped to an estimated 18° Celsius (65° Fahrenheit) below the thermocline.

A listing of samples including location, depth, time, and bedform description is in Table C-1. Table C-2 lists the RSA results for size analyses. Samples containing a significant amount of silt-sized material (finer than 0.625 millimeter) cannot be reliably analyzed with the RSA; therefore, results from these should be interpreted with caution. The samples could be wet-sieved to determine the percentage of silt. Techniques are available to analyze size distribution within the silt fraction, if required. Samples that have a significant silt fraction include the following: I-4, I-5, II-1, II-2, III-1, III-2, III-3, III-4, III-6, and V-2. All size data are representative of composite samples of the 40-centimeter (approximate) core, with the exception of samples V-4, V-6, and V-8. Part of the core sampler was lost, so the last three samples represent only the top 2 or 3 centimeters of the bottom.

Bottom sediment ranged from medium sand in the vicinity of the pier to sandy silt and mud at the 12- to 14-meter depth. Very fine sand occurs farther offshore at the Waverider location (15.8-meter depth). No gravel was observed.

The bottom was generally observed to be rippled, except in the surf zone where ripples were wiped out by the surge of passing breakers. Ripples were generally shore-parallel with wavelengths ranging from 4 to 12 centimeters and heights of 1 to 4 centimeters. At station III-10 (2.9-meter depth) megaripples were the primary bed form with smaller ripples superimposed. Megaripple wavelength was 2 meters and height was 15 centimeters. It is possible that megaripples occurred at other stations but were not detected due to poorer visibility. Attempts were made to photograph these features but were not successful due to flooding of the underwater camera.

For further information, please contact Allan E. DeWall at (202) 325-7380.

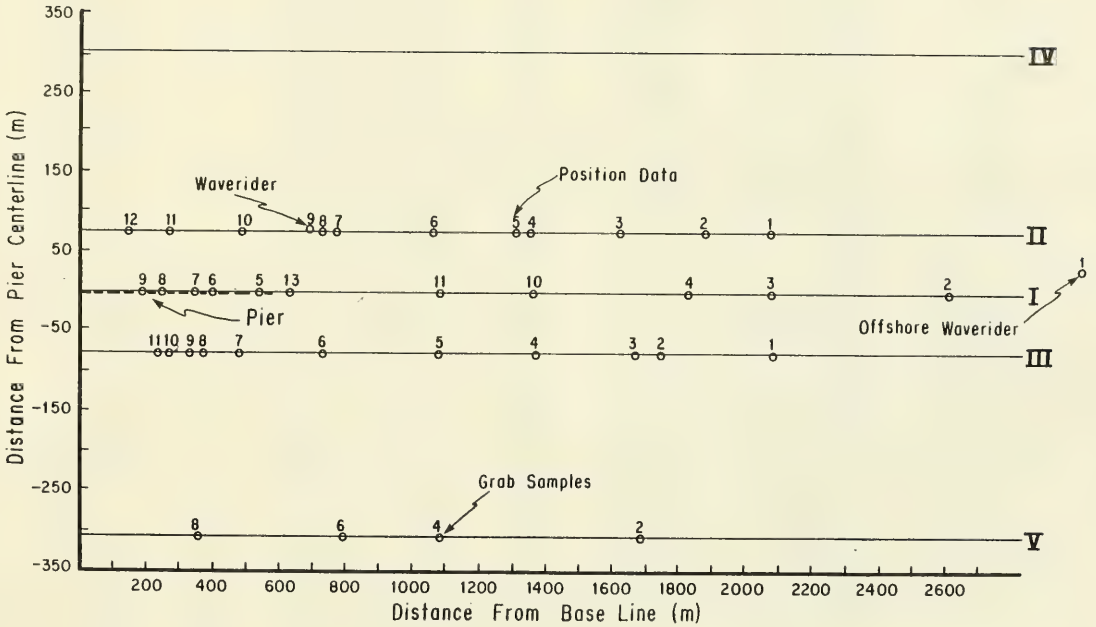


Figure C-1. Sand sample locations at Duck, North Carolina, 7-9 August 1979.

Table C-1. Offshore samples, Duck, North Carolina, 7-9 August 1979.

Sample No.	Range (m)	Distance (m)	Depth (m)	Date	Time	Description
I-1	35 N.	3341	15.8	7	12:44	At Waverider--very fine sand bottom with sea-like ripples (two directions); λ = 7 cm a = 1 cm κ = 20° (estimate)
I-2	0	2610	15.2	7	13:12	Clean, very fine sand, ripples (two directions); λ = 10 cm a = 1 cm κ = 20° (estimate)
I-3	0	2085	13.1	7	13:30	Very fine sand, ripples, zero visibility; λ = 10 cm a = 1 cm
I-4	0	1838	11.9	7	13:45	Mud and silt bottom, no bedforms, zero visibility.
I-5	0	550	8.2	8	10.55	Under pier--fine sand and silt, organic debris (muscle shells), no bedforms, zero visibility.
I-6	0	410	6.4	8	11:07	Under pier--medium sand, oscillation ripples; a = 2 cm
I-7	0	350	4.6	8	11:20	Under pier--medium sand, scour holes, straight ripples; λ = 8 cm a = 4 cm κ = 45°
I-8	0	250	4.6	8	11:27	Under pier--medium sand, broken sinuous ripples; λ = 6 cm a = 3 cm
I-9	0	210	1.2	8	11:40	Under pier--medium sand, straight ripples; λ = 10 cm a = 4 cm κ = 0° (at right angle to pier axis)
I-10	0	1366	10.7	9	14:40	Very fine sand, ripples; λ = 9 to 10 cm a = 1.5 cm κ = 5°
I-11	0	1093	8.8	9	14:56	Fine sand, ripples; λ = 8 cm a = 1.5 cm κ = 0°
I-13	0	640	6.7	9	15:20	Fine sand, ripples; λ = 6 cm a = 10 cm κ = 355°
II-1	76 N.	2090	14.6	7	16:51	Fine sand and silt bottom, oscillation ripples; λ = 6 cm a = 2 cm
II-2	76 N.	1890	12.8	7	17:06	Silt on fine sand, oscillation ripples; λ = 6 cm a = 2 cm
II-3	76 N.	1647	12.5	7	17:19	Fine sand, sinuous ripples merge with oscillation ripples; λ = 8 cm a = 2 cm

Table C-1. Offshore samples, Duck, North Carolina, 7-9 August 1979.--Continued

Sample No.	Range (m)	Distance (m)	Depth (m)	Date	Time	Description
II-4	76 N.	1361	11.9	7	17:32	Fine sand, sinuous to linguoid ripples; λ = 4 cm α = 2 cm κ = 20° (estimate)
II-5	76 N.	1340	11.0	7	14:30	Very fine to fine sand, two ripple sets, bioactive (snails, worms), good visibility; λ = 5 to 10 cm α = 1 to 2 cm κ = 0°
II-6	76 N.	1085	9.4	7	14:43	Fine sand, ripples, organic debris, abundant bottom life, good visibility; λ = 5 cm α = 1 to 2 cm κ = 10°
II-7	76 N.	787	7.3	7	15:08	Fine sand, ripples, abundant bottom fauna with scant sand dollar zone; λ = 5 to 8 cm α = 1 to 1.5 cm κ = 350°
II-8	76 N.	736	7.3	7	15:22	Fine sand, two to three ripple sets, poor visibility; λ = 8 to 12 cm α = 2 to 4 cm κ = 350°
II-9	79 N.	704	6.7	7	15:38	At waverider buoy--fine to medium sand bottom, two ripple sets, sparce bottom fauna; λ = 2 to 6 cm α = 1 to 2 cm κ = 0°
II-10	76 N.	497	5.2	7	15:54	Fine to medium sand bottom, two ripple sets, sparce bottom fauna; λ = 5 cm α = 1 cm κ = 10°
II-11	76 N.	283	2.7	7	16:15	Medium sand and shell fragments, two ripple sets, heavy minerals in troughs; λ = 5 to 8 cm α = 1 to 2 cm κ = 350°
III-1	76 S.	2090	14.6	8	10:30	Fine sand and silt bottom, oscillation ripples strong bioactivity, zero visibility; α = 1 to 2 cm
III-2	76 S.	1750	14.6	9	09:44	Very fine silty sand, ripples, no visibility.
III-3	76 S.	1675	14.0	9	10:07	Very fine sand, ripples, no visibility.
III-4	76 S.	1370	10.7	9	10:33	Fine sand, ripples; λ = 7.5 to 8 cm α = 1 cm κ = 15°
III-5	76 S.	1088	9.8	9	10:50	Fine sand, ripples; λ = 9 cm α = 1.5 cm κ = 5°
III-6	76 S.	743	7.9	9	11:08	Fine sand, ripples, 1-mile visibility; λ = 7 to 10 cm α = 2 cm κ = 10°

Table C-1. Offshore samples, Duck, North Carolina, 7-9 August 1979.--Continued

Sample No.	Range (m)	Distance (m)	Depth (m)	Date	Time	Description
III-7	76 S.	491	6.6	9	11:25	Fine sand, ripples, 0.5-mile visibility; λ = 6 cm κ = 0°
III-8	76 S.	379	4.1	9	11:41	Fine sand, ripples, 2-mile visibility; λ = 9 to 10 cm α = 1 to 1.5 cm κ = 355°
III-9	76 S.	343	3.7	9	11:56	Fine sand, ripples, transitional to plane bed during wave crest passage, 2-mile visibility; λ = 5 to 8 cm κ = 350°
III-10	76 S.	275	2.9	9	12:16	Fine sand, ripples on mega ripples; λ = 2 m α = 15 cm κ = 0° Ripples; λ = 7 to 8 cm κ = 0°
III-11	76 S.	251	2.7	9	12:42	Fine sand, ripples in transition; λ = 6 to 8 cm α = 1 cm (to plane bed) κ = 355°
V-2	305 S.	1688	13.4	9	15:46	Silt, ripples, no visibility
V-4	305 S.	1080	9.1	9	16:09	Fine sand, ripples, 1.5-mile visibility; λ = 9 to 10 cm α = 2 to 2.5 cm κ = 355°
V-6	305 S.	794	7.6	9	16:55	Fine sand, ripples, 1.5-mile visibility; λ = 9 to 10 cm α = 3 cm κ = 0°
V-8	305 S.	356	3.0	9	17:15	Fine sand, linguoid ripples, 2-mile visibility; λ = 9 to 10 cm κ = 340° (primary) κ = 0° (secondary)

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.

Sample No.	Range	Distance from base line	Water depth	Date	Time	Size		Cumulative	Statistical parameters						
									Median		Mean		Std. dev.	Skewness	Kurtosis
	(m)	(m)	(m)			(phi)	(mm)	(pct)	(phi)	(mm)	(phi)	(mm)	(phi)	(phi)	(phi)
I-1	35 N.	3341	15.8	7	12:44	1.00	0.500	0.00	2.86	0.138	2.76	0.147	0.51	0.51	2.27
						1.50	0.354	0.35							
						2.00	0.250	9.33							
						2.50	0.177	31.34							
						3.00	0.125	59.44							
						3.50	0.088	98.69							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
I-2	0	2610	15.2	7	13:12	0.00	1.000	0.00	2.55	0.171	2.48	0.179	0.59	0.65	3.45
						0.50	0.707	0.43							
						1.00	0.500	2.03							
						1.50	0.354	4.58							
						2.00	0.250	23.68							
						2.50	0.177	46.88							
						3.00	0.125	79.21							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
I-3	0	2085	13.1	7	13:30	9.50	1.414	0.00	2.95	0.130	2.83	0.141	0.56	-1.46	5.86
						0.00	1.000	0.06							
						0.50	0.707	0.45							
						1.00	0.500	0.85							
						1.50	0.354	3.62							
						2.00	0.250	8.36							
						2.50	0.177	21.42							
						3.00	0.125	54.11							
						3.50	0.088	97.40							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
I-5	0	550	8.2	8	10:55	-1.00	2.000	0.00	2.62	0.163	2.47	0.180	0.64	-2.04	8.42
						4.50	1.414	0.18							
						0.00	1.000	1.51							
						0.50	0.707	2.58							
						1.00	0.500	4.42							
						1.50	0.354	6.38							
						2.00	0.250	14.28							
						2.50	0.177	40.95							
						3.00	0.125	84.34							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

Sample No.	Range (m)	Distance from base line (m)	Water depth (m)	Date	Time	Size (phi)	Size (mm)	Cumulative (pct)	Statistical parameters: Median (phi)	Median (mm)	Mean (phi)	Mean (mm)	Std. dev. (phi)	Skewness (phi)	Kurtosis (phi)
I-6	0	410	6.4	8	11:07	-1.00	2.000	0.00	2.18	0.221	2.05	0.241	0.63	-1.87	7.21
						-0.50	1.414	0.35							
						0.00	1.000	2.70							
						0.50	0.707	4.00							
						1.00	0.500	7.38							
						1.50	0.354	11.21							
						2.00	0.250	40.99							
						2.50	0.177	77.72							
						3.00	0.125	100.00							
						3.50	0.088	100.00							
						4.00	0.062	100.00							
I-7	0	350	4.6	8	11:20	-1.00	2.000	0.00	2.16	0.224	2.03	0.244	0.70	-1.31	5.24
						-0.50	1.414	0.61							
						0.00	1.000	2.40							
						0.50	0.707	5.01							
						1.00	0.500	7.12							
						1.50	0.354	14.70							
						2.00	0.250	42.97							
						2.50	0.177	73.83							
						3.00	0.125	99.43							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
I-8	0	250	4.6	8	11:27	0.50	0.707	0.00	2.39	0.190	2.31	0.202	0.48	-1.02	4.12
						1.00	0.500	2.34							
						1.50	0.354	6.14							
						2.00	0.250	25.68							
						2.50	0.177	58.97							
						3.00	0.125	99.23							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
I-9	0	210	1.2	8	11:40	-0.50	1.414	0.00	1.89	0.270	1.80	0.288	0.66	-0.89	3.92
						0.00	1.000	2.44							
						0.50	0.707	5.44							
						1.00	0.500	7.87							
						1.50	0.354	32.95							
						2.00	0.250	56.16							
						2.50	0.177	86.69							
						3.00	0.125	100.00							
						3.50	0.088	100.00							
						4.00	0.062	100.00							

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

Sample No.	Range	Distance from base line	Water depth	Date	Time	Size		Cumulative	Statistical parameters						
									Median		Mean		Std. dev.	Skewness	Kurtosis
	(m)	(m)	(m)			(phi)	(mm)	(pct)	(phi)	(mm)	(phi)	(mm)	(phi)	(phi)	(phi)
I-10	0	1366	10.7	9	14:40	0.50	0.707	0.00	2.87	0.137	2.77	0.147	0.54	-1.49	5.61
						1.00	0.500	1.30							
						1.50	0.354	4.18							
						2.00	0.250	9.16							
						2.50	0.177	20.70							
						3.00	0.125	60.51							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
I-11	0	1093	8.8	9	14:56	-1.00	2.000	0.00	2.67	0.157	2.47	0.181	0.83	-1.87	6.33
						-0.50	1.414	0.62							
						0.00	1.000	2.85							
						0.50	0.707	5.62							
						1.00	0.500	8.32							
						1.50	0.354	10.64							
						2.00	0.250	15.83							
						2.50	0.177	40.56							
						3.00	0.125	74.37							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
I-13	0	640	6.7	9	15:20	-1.00	2.000	0.00	2.74	0.149	2.27	0.208	1.31	-1.43	3.52
						-0.50	1.414	8.88							
						0.00	1.000	16.47							
						0.50	0.707	16.87							
						1.00	0.500	17.45							
						1.50	0.354	18.37							
						2.00	0.250	18.45							
						2.50	0.177	37.13							
						3.00	0.125	67.67							
						3.50	0.088	98.36							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-1	76 N.	2090	14.6	7	16:51	1.50	0.354	0.00	3.01	0.124	2.98	0.129	0.44	-0.52	2.73
						2.00	0.250	2.31							
						2.50	0.177	17.96							
						3.00	0.125	49.14							
						3.50	0.088	91.44							
						4.00	0.063	100.00							
						4.00	0.062	100.00							

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

Sample No.	Range	Distance from base line	Water depth	Date	Time	Size		Cumulative	Statistical parameters						
									Median		Mean		Std. dev.	Skewness	Kurtosis
	(m)	(m)	(m)			(phi)	(mm)	(pct)	(phi)	(mm)	(phi)	(mm)	(phi)	(phi)	(phi)
II-2	76 N.	1890	12.8	7	17:06	-0.50	1.414	0.00	3.08	0.118	2.97	0.127	0.70	-1.40	6.08
						0.00	1.000	0.51							
						0.50	0.707	1.23							
						1.00	0.500	1.99							
						1.50	0.354	3.88							
						2.00	0.250	8.05							
						2.50	0.177	18.64							
						3.00	0.125	44.89							
						3.50	0.088	76.73							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-3	76 N.	1647	12.5	7	17:19	-1.00	2.000	0.00	2.96	0.129	2.83	0.141	0.62	-2.20	9.67
						-0.50	1.414	0.15							
						0.00	1.000	0.54							
						0.50	0.707	1.92							
						1.00	0.500	2.71							
						1.50	0.354	4.81							
						2.00	0.250	7.32							
						2.50	0.177	18.48							
						3.00	0.125	52.91							
						3.50	0.088	97.50							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-4	76 N.	1361	11.9	7	17:32	-0.50	1.414	0.00	2.75	0.149	2.64	0.160	0.58	-2.10	9.56
						0.00	1.000	0.80							
						0.50	0.707	1.70							
						1.00	0.500	2.43							
						1.50	0.354	4.41							
						2.00	0.250	8.66							
						2.50	0.177	32.62							
						3.00	0.125	71.66							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-5	76 N.	1340	11.0	7	14:30	0.00	1.000	0.00	2.85	0.138	2.77	0.147	0.51	-1.74	7.76
						0.50	0.707	0.79							
						1.00	0.500	1.07							
						1.50	0.354	3.26							
						2.00	0.250	6.16							
						2.50	0.177	23.35							
						3.00	0.125	63.70							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

Sample No.	Range	Distance from base line	Water depth	Date	Time	Size		Cumulative	Statistical parameters						
									Median		Mean		Std. dev.	Skewness	Kurtosis
	(m)	(m)	(m)			(phi)	(mm)	(pct)	(phi)	(mm)	(phi)	(mm)	(phi)	(phi)	(phi)
II-6	76 N.	1085	9.4	7	14:43	-0.50	1.414	0.00	2.79	0.145	2.71	0.153	0.55	-1.96	9.19
						0.00	1.000	0.25							
						0.50	0.707	1.30							
						1.00	0.500	2.47							
						1.50	0.354	2.97							
						2.00	0.250	7.30							
						2.50	0.177	26.94							
						3.00	0.125	69.63							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-7	76 N.	787	7.3	7	15:08	-0.50	1.414	0.00	2.77	0.147	2.69	0.155	0.57	-1.97	8.99
						0.00	1.000	0.83							
						0.50	0.707	1.24							
						1.00	0.500	2.34							
						1.50	0.354	4.64							
						2.00	0.250	8.17							
						2.50	0.177	27.23							
						3.00	0.125	69.09							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-8	76 N.	736	7.3	7	15:22	0.50	0.707	0.00	2.61	0.164	2.60	0.164	0.46	-0.26	2.89
						1.00	0.500	0.04							
						1.50	0.354	1.69							
						2.00	0.250	7.01							
						2.50	0.177	42.12							
						3.00	0.125	78.17							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-9	76 N.	704	6.7	7	15:38	-1.00	2.000	0.00	1.97	0.256	1.79	0.269	0.61	-1.41	4.53
						-0.50	1.414	0.10							
						0.00	1.000	1.85							
						0.50	0.707	6.11							
						1.00	0.500	11.81							
						1.50	0.354	23.22							
						2.00	0.250	52.94							
						2.50	0.177	100.00							
						3.00	0.125	100.00							
						4.00	0.062	100.00							

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

Sample No.	Range	Distance from base line	Water depth	Date	Time	Size		Cumulative	Statistical parameters						
									Median		Mean		Std. dev.	Skewness	Kurtosis
	(m)	(m)	(m)			(phi)	(mm)	(pct)	(phi)	(mm)	(phi)	(mm)	(phi)	(phi)	(phi)
II-10	76 N.	497	5.2	7	15:54	-1.00	2.000	0.00	2.37	0.193	2.32	0.200	0.64	-1.06	5.63
						-0.50	1.414	0.22							
						0.00	1.000	1.24							
						0.50	0.707	1.47							
						1.00	0.500	3.01							
						1.50	0.354	4.95							
						2.00	0.250	29.61							
						2.50	0.177	57.67							
						3.00	0.125	86.01							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-11	76 N.	283	2.7	7	16:15	-1.00	2.000	0.00	2.24	0.212	2.14	0.226	0.63	-1.54	6.48
						-0.50	1.414	0.22							
						0.00	1.000	2.13							
						0.50	0.707	2.69							
						1.00	0.500	5.90							
						1.50	0.354	9.21							
						2.00	0.250	38.27							
						2.50	0.177	68.77							
						3.00	0.125	99.47							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
II-12	76 N.	159	1.5	7		-1.00	2.000	0.00	2.01	0.248	2.03	0.244	0.91	-0.35	3.42
						-0.50	1.414	0.76							
						0.00	1.000	3.80							
						0.50	0.707	5.96							
						1.00	0.500	6.93							
						1.50	0.354	28.88							
						2.00	0.250	49.56							
						2.50	0.177	72.37							
						3.00	0.125	83.10							
						3.50	0.088	93.38							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-1	76 S.	2090	14.6	8	10:30	-0.50	1.414	0.00	3.11	0.116	2.99	0.126	0.62	-2.01	8.30
						0.00	1.000	0.10							
						0.50	0.707	1.19							
						1.00	0.500	2.12							
						1.50	0.354	3.96							
						2.00	0.250	6.84							
						2.50	0.177	11.47							
						3.00	0.125	40.49							
						3.50	0.088	84.34							
						4.00	0.063	100.00							
						4.00	0.062	100.00							

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

Sample No.	Range	Distance from base line	Water depth	Date	Time	Size		Cumulative	Statistical parameters						
									Median		Mean		Std. dev.	Skewness	Kurtosis
	(m)	(m)	(m)			(phi)	(mm)	(pct)	(phi)	(mm)	(phi)	(mm)	(phi)	(phi)	(phi)
III-2	76 S.	1750	14.6	9	09:44	-1.00	2.000	0.00	2.93	0.131	2.78	0.146	0.76	-2.50	10.59
						-0.50	1.414	0.91							
						0.00	1.000	2.98							
						0.50	0.707	3.67							
						1.00	0.500	4.16							
						1.50	0.354	5.71							
						2.00	0.250	7.65							
						2.50	0.177	20.18							
						3.00	0.125	54.67							
						3.50	0.088	93.72							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-3	76 S.	1675	14.0	9	10:07	-0.50	1.414	0.00	2.98	0.127	2.89	0.135	0.58	-1.81	8.50
						0.00	1.000	0.36							
						0.50	0.707	1.06							
						1.00	0.500	1.63							
						1.50	0.354	3.21							
						2.00	0.250	5.78							
						2.50	0.177	20.49							
						3.00	0.125	51.98							
						3.50	0.088	91.97							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-4	76 S.	1370	10.7	9	10:33	-1.00	2.000	0.00	2.94	0.130	2.86	0.138	0.64	-2.19	10.71
						-0.50	1.414	0.37							
						0.00	1.000	1.25							
						0.50	0.707	1.31							
						1.00	0.500	2.28							
						1.50	0.354	4.00							
						2.00	0.250	6.36							
						2.50	0.177	16.94							
						3.00	0.125	54.43							
						3.50	0.088	89.10							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-5	76 S.	1088	9.8	9	10:50	0.50	0.707	0.00	2.86	0.138	2.00	0.143	0.47	-0.94	4.43
						1.00	0.500	0.33							
						1.50	0.354	2.25							
						2.00	0.250	5.69							
						2.50	0.177	24.92							
						3.00	0.125	62.38							
						3.50	0.088	97.99							
						4.00	0.063	100.00							
						4.00	0.062	100.00							

Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

Sample No.	Range (m)	Distance from base line (m)	Water depth (m)	Date	Time	Size (phi)	Size (mm)	Cumulative (pct)	Statistical parameters: Median (phi)	Median (mm)	Mean (phi)	Mean (mm)	Std. dev. (phi)	Skewness (phi)	Kurtosis (phi)
III-6	76 S.	743	7.9	9	11:08	0.00	1.000	0.00	2.87	0.136	2.86	0.138	0.50	-0.77	4.74
						0.50	0.707	0.18							
						1.00	0.500	0.44							
						1.50	0.354	1.78							
						2.00	0.250	3.92							
						2.50	0.177	23.35							
						3.00	0.125	59.42							
						3.50	0.088	89.43							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-7	76 S.	491	6.6	9	11:25	0.00	1.000	0.00	2.70	0.154	2.68	0.156	0.54	-0.82	5.06
						0.50	0.707	0.44							
						1.00	0.500	1.49							
						1.50	0.354	3.05							
						2.00	0.250	5.15							
						2.50	0.177	35.16							
						3.00	0.125	73.62							
						3.50	0.088	95.14							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-8	76 S.	379	4.1	9	11:41	0.50	0.707	0.00	2.45	0.183	2.44	0.184	0.51	-0.48	3.87
						1.00	0.500	1.80							
						1.50	0.354	3.44							
						2.00	0.250	16.75							
						2.50	0.177	53.95							
						3.00	0.125	85.82							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-9	76 S.	343	3.7	9	11:56	0.50	0.707	0.00	2.29	0.205	2.26	0.209	0.55	-0.13	2.65
						1.00	0.500	1.57							
						1.50	0.354	3.87							
						2.00	0.250	33.60							
						2.50	0.177	65.71							
						3.00	0.125	89.93							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
III-10	76 S.	275	2.9	9	12:16	0.00	1.000	0.00	2.13	0.228	2.15	0.225	0.59	-0.13	2.92
						0.50	0.707	0.84							
						1.00	0.500	3.05							
						1.50	0.354	9.40							
						2.00	0.250	43.45							
						2.50	0.177	71.79							
						3.00	0.125	90.76							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							

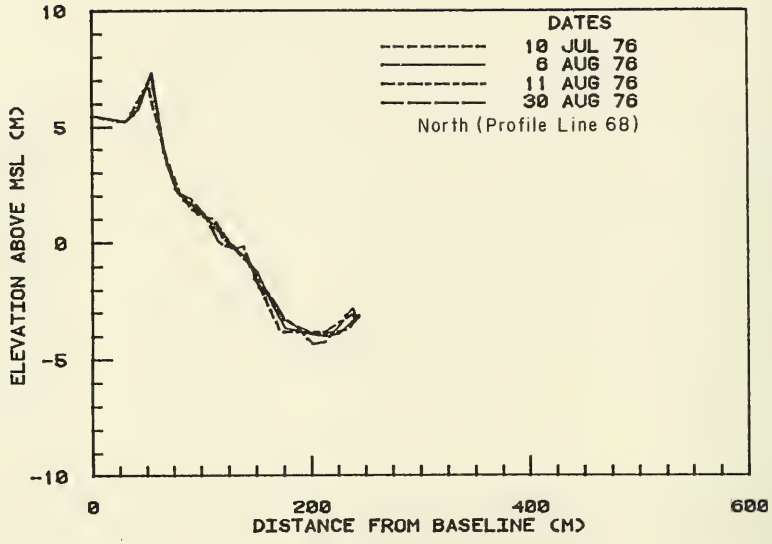
Table C-2. RSA results for sediment size analyses, Duck, North Carolina, 7-9 August 1979.--Continued.

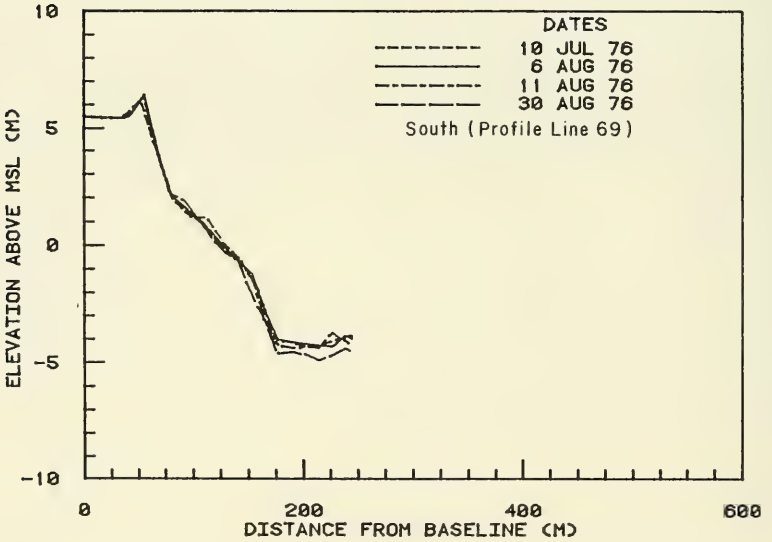
Sample No.	Range (m)	Distance from base line (m)	Water depth (m)	Date 9	Time	Size (phi)	Size (mm)	Cumulative (pct)	Statistical parameters: Median (phi)	Median (mm)	Mean (phi)	Mean (mm)	Std. dev. (phi)	Skewness (phi)	Kurtosis (phi)
III-11	76 S.	251	2.7	9	12:42	-0.50	1.414	0.00	2.41	0.188	2.46	0.182	0.61	-0.39	4.48
						0.00	1.000	0.49							
						0.50	0.707	0.79							
						1.00	0.500	1.54							
						1.50	0.354	3.68							
						2.00	0.250	21.20							
						2.50	0.177	55.63							
						3.00	0.125	80.51							
						3.50	0.088	95.71							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
V-2	305 S.	1688	13.4	9	15:46	-1.00	2.000	0.00	3.19	0.110	3.09	0.118	0.61	-1.82	9.15
						-0.50	1.414	0.12							
						0.00	1.000	0.58							
						0.50	0.707	0.72							
						1.00	0.500	0.86							
						1.50	0.354	2.72							
						2.00	0.250	5.05							
						2.50	0.177	10.83							
						3.00	0.125	36.51							
						3.50	0.088	75.09							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
V-4	305 S.	1080	9.1	9	16:09	1.50	0.354	0.00	3.08	0.118	3.05	0.121	0.28	-0.15	2.02
						2.00	0.250	0.00							
						2.50	0.177	0.00							
						3.00	0.125	39.46							
						3.50	0.088	97.61							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
V-6	305 S.	794	7.6	9	16:55	-0.50	1.414	0.00	2.84	0.139	2.73	0.150	0.62	-1.97	8.16
						0.00	1.000	0.13							
						0.50	0.707	1.97							
						1.00	0.500	3.34							
						1.50	0.354	5.70							
						2.00	0.250	7.74							
						2.50	0.177	25.49							
						3.00	0.125	64.27							
						3.50	0.088	98.25							
						4.00	0.063	100.00							
						4.00	0.062	100.00							
V-8	305 S.	356	3.0	9	17:15	0.00	1.000	0.00	2.37	0.193	2.34	0.198	0.54	-0.58	3.68
						0.50	0.707	0.29							
						1.00	0.500	2.16							
						1.50	0.354	5.12							
						2.00	0.250	25.30							
						2.50	0.177	59.31							
						3.00	0.125	89.11							
						3.50	0.088	100.00							
						4.00	0.063	100.00							
						4.00	0.062	100.00							

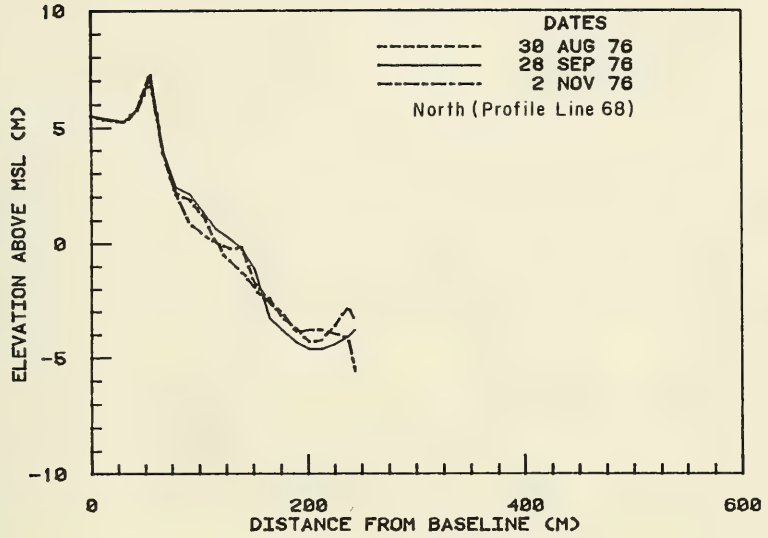
APPENDIX D

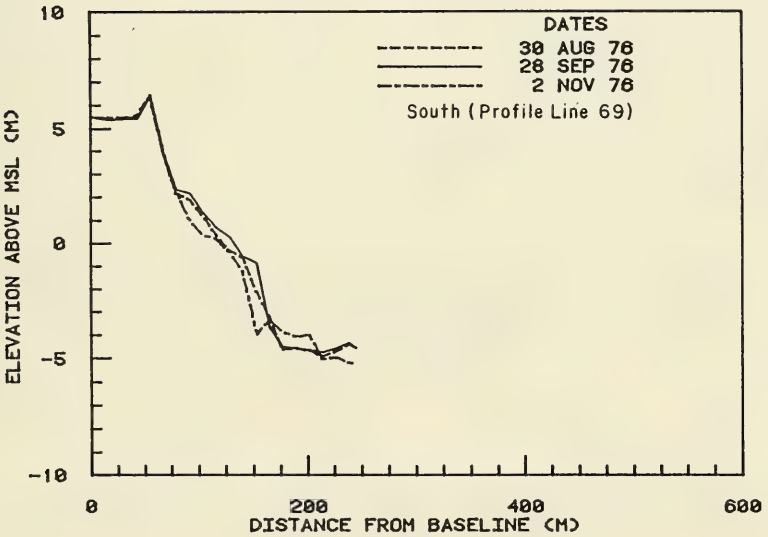
SURVEY DATA

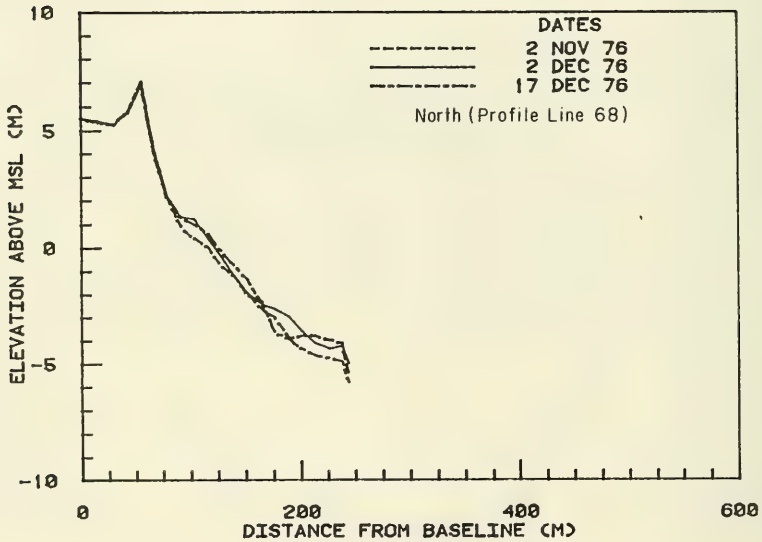
This appendix contains monthly graphs of profiles obtained from both sides of the FRF pier. The north side of the pier is designated profile line 68 while the south side profile line is 69.

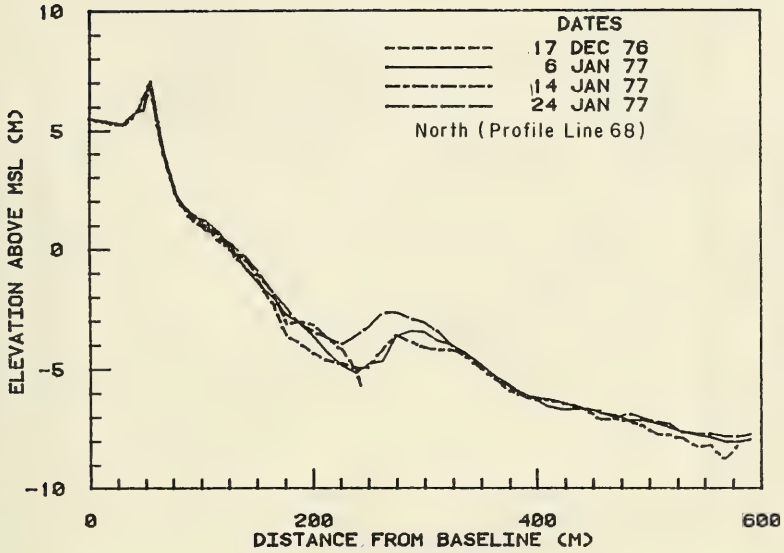

DATES
10 JUL 76
6 AUG 76
11 AUG 76
30 AUG 76
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)

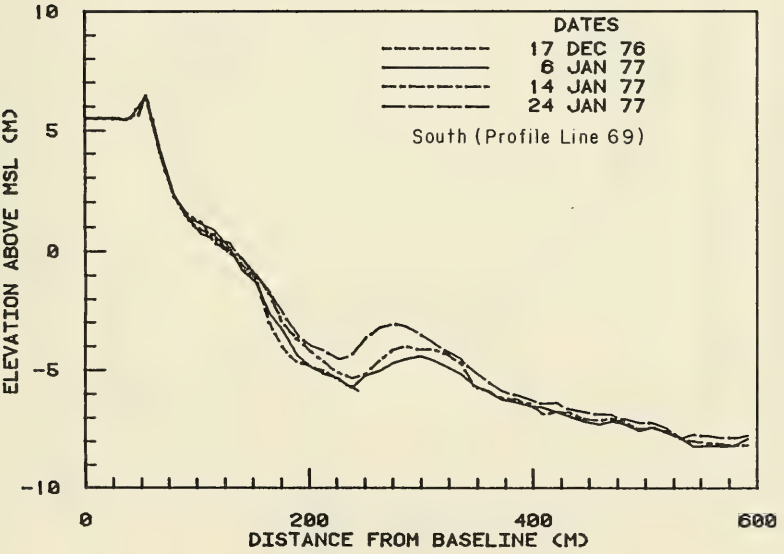

DATES
10 JUL 76
6 AUG 76
11 AUG 76
30 AUG 76
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)

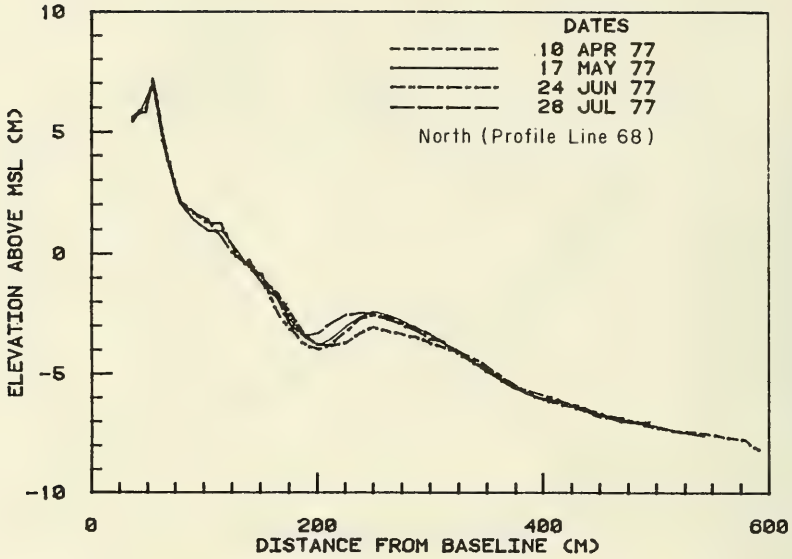

DATES
30 AUG 76
28 SEP 76
2 NOV 76
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)

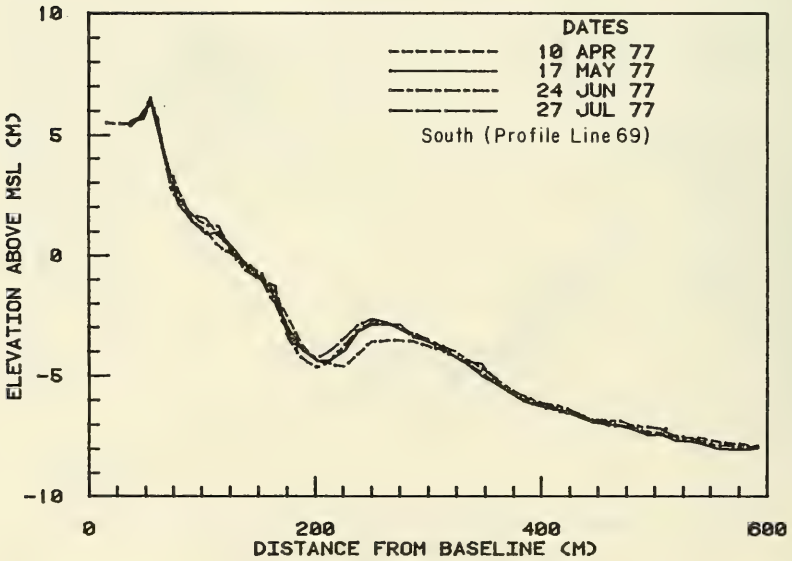

DATES
30 AUG 76
28 SEP 76
2 NOV 76
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)

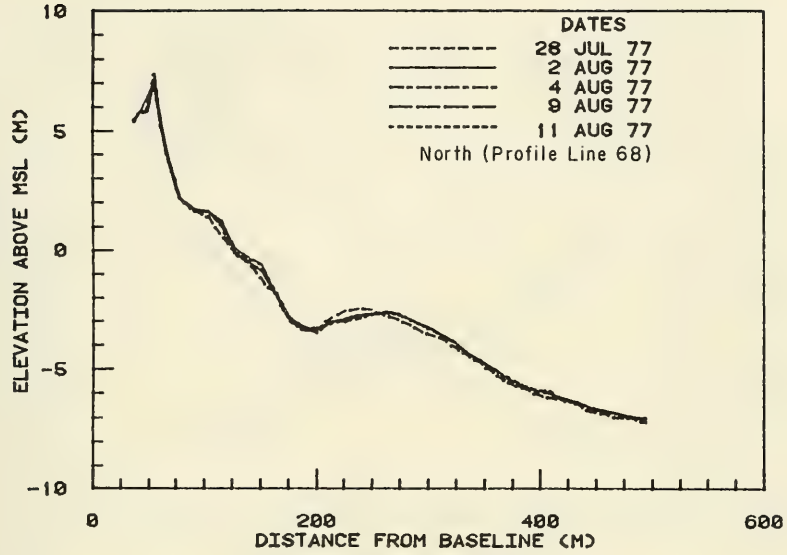

DATES
2 NOV 76
2 DEC 76
17 DEC 76
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
17 DEC 76
6 JAN 77
14 JAN 77
24 JAN 77
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
17 DEC 76
6 JAN 77
14 JAN 77
24 JAN 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
10 APR 77
17 MAY 77
24 JUN 77
28 JUL 77
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
10 APR 77
17 MAY 77
24 JUN 77
27 JUL 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
28 JUL 77
2 AUG 77
4 AUG 77
9 AUG 77
11 AUG 77
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
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-5
-10
0
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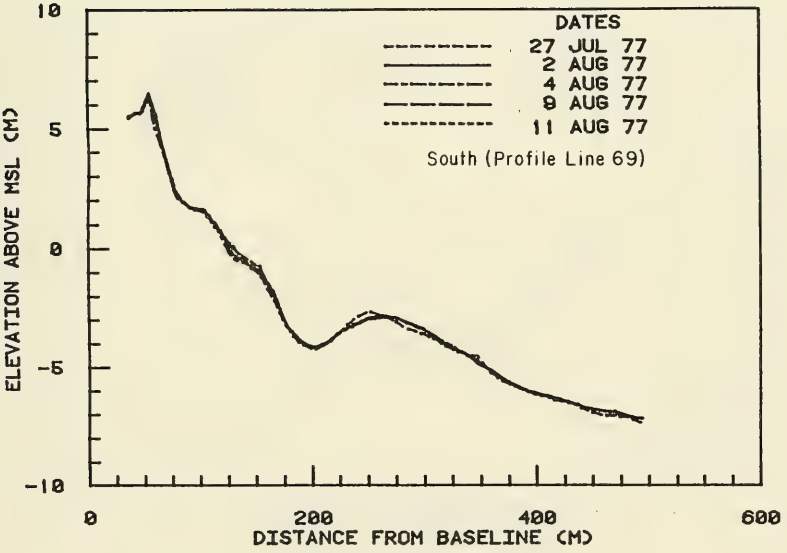
400
600
DISTANCE FROM BASELINE (M)


DATES
27 JUL 77
2 AUG 77
4 AUG 77
9 AUG 77
11 AUG 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
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-5
-10
0
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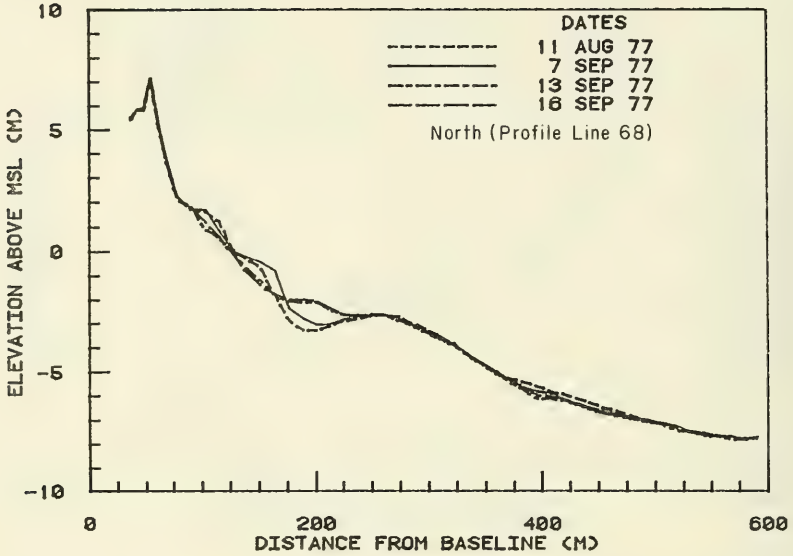
400
600
DISTANCE FROM BASELINE (M)


DATES
11 AUG 77
7 SEP 77
13 SEP 77
16 SEP 77
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
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-5
-10
0
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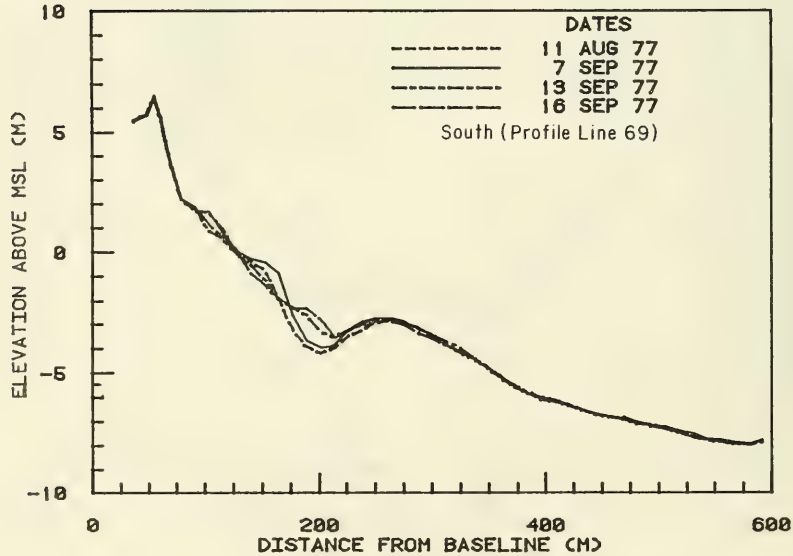
400
600
DISTANCE FROM BASELINE (M)


DATES
11 AUG 77
7 SEP 77
13 SEP 77
16 SEP 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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5
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-5
-10
0
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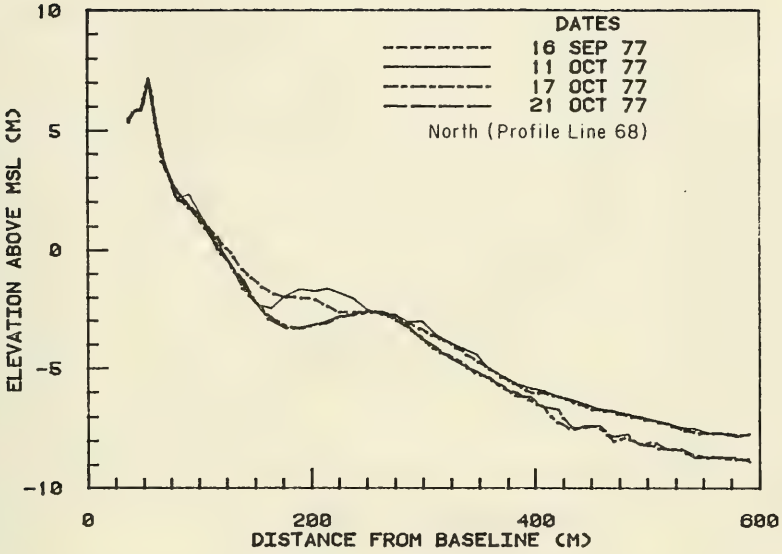
600
DISTANCE FROM BASELINE (M)


DATES
16 SEP 77
11 OCT 77
17 OCT 77
21 OCT 77
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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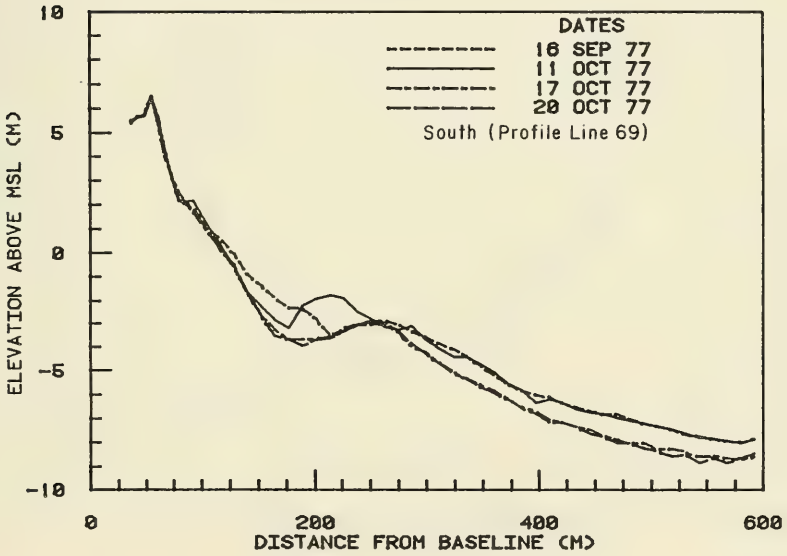
600
DISTANCE FROM BASELINE (M)


DATES
16 SEP 77
11 OCT 77
17 OCT 77
20 OCT 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
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-5
-10
0
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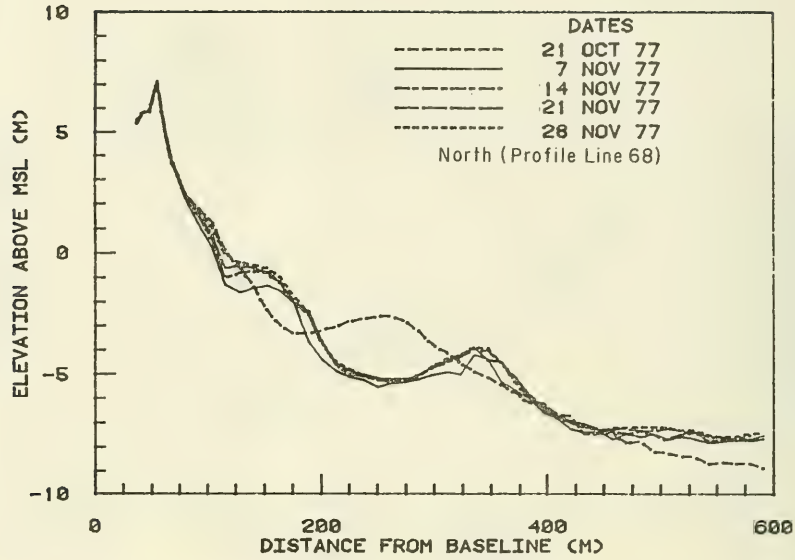
400
600
DISTANCE FROM BASELINE (M)


DATES
21 OCT 77
7 NOV 77
14 NOV 77
21 NOV 77
28 NOV 77
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
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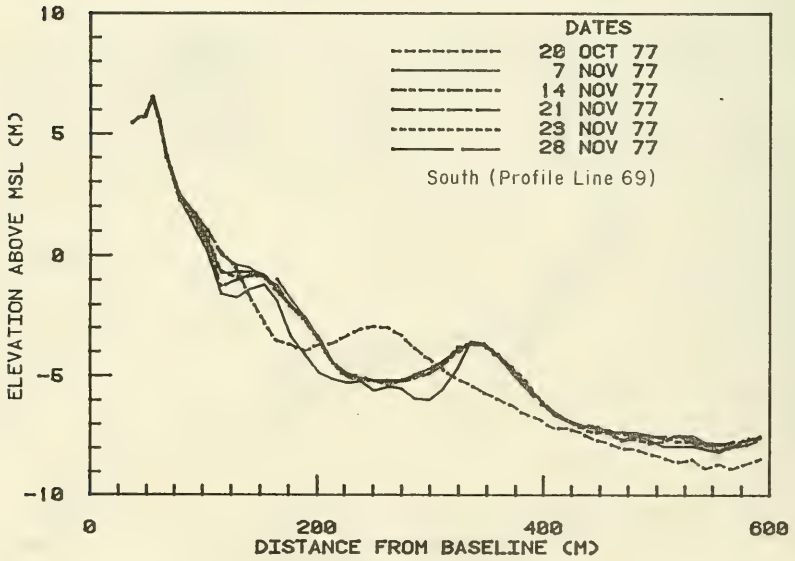
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
20 OCT 77
7 NOV 77
14 NOV 77
21 NOV 77
23 NOV 77
28 NOV 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
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-5
-10
0
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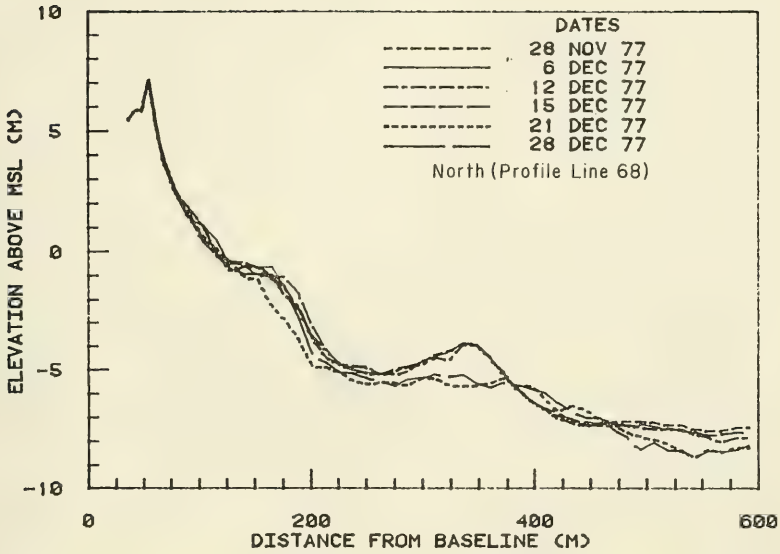
600
DISTANCE FROM BASELINE (M)


DATES
28 NOV 77
6 DEC 77
12 DEC 77
15 DEC 77
21 DEC 77
28 DEC 77
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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5
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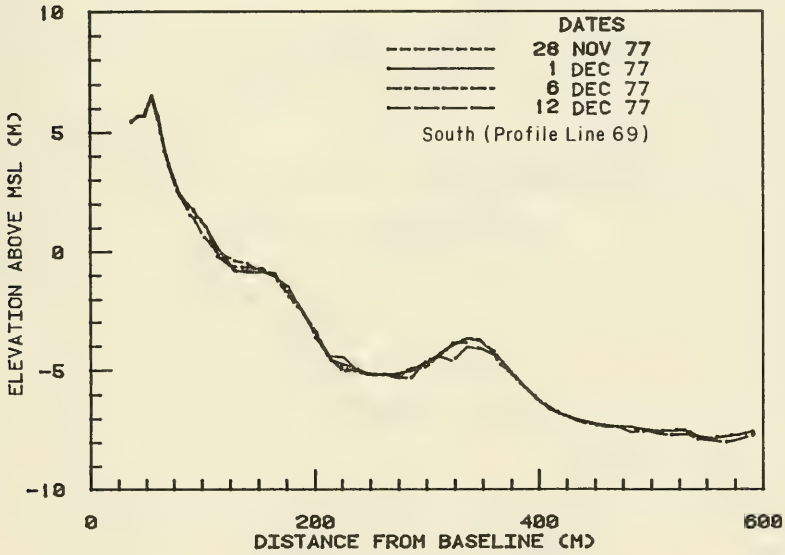
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
28 NOV 77
1 DEC 77
6 DEC 77
12 DEC 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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-5
-10
0
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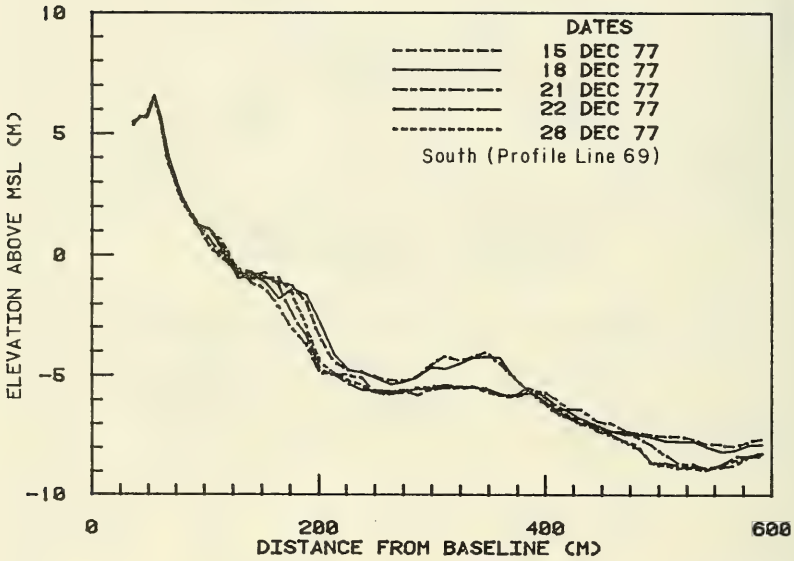
400
600
DISTANCE FROM BASELINE (M)


DATES
15 DEC 77
18 DEC 77
21 DEC 77
22 DEC 77
28 DEC 77
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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5
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-5
-10
0
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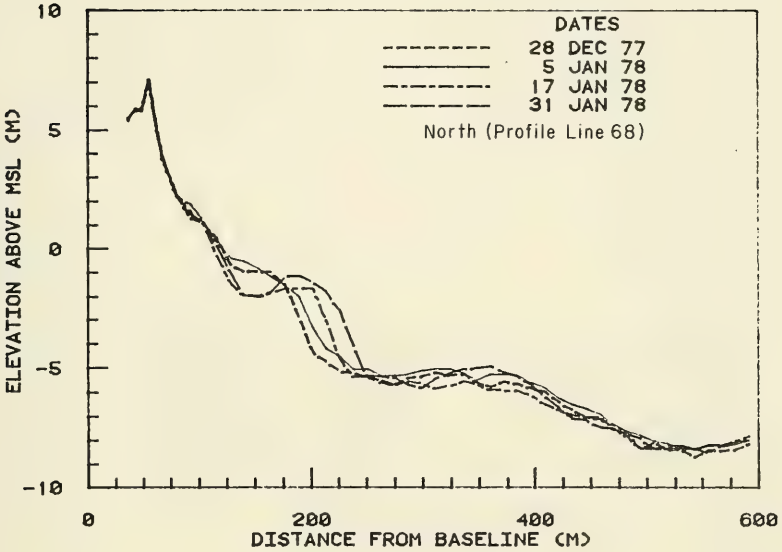
400
600
DISTANCE FROM BASELINE (M)


DATES
28 DEC 77
5 JAN 78
17 JAN 78
31 JAN 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
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-5
-10
0
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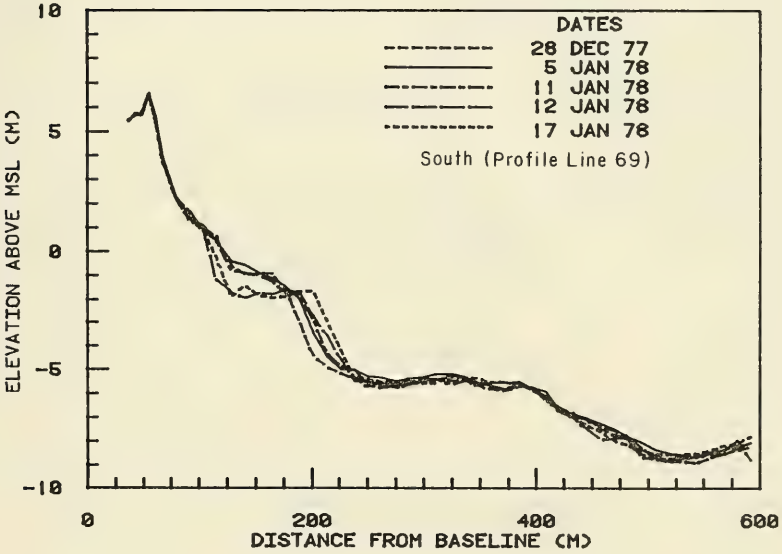
400
600
DISTANCE FROM BASELINE (M)


DATES
28 DEC 77
5 JAN 78
11 JAN 78
12 JAN 78
17 JAN 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
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-5
-10
0
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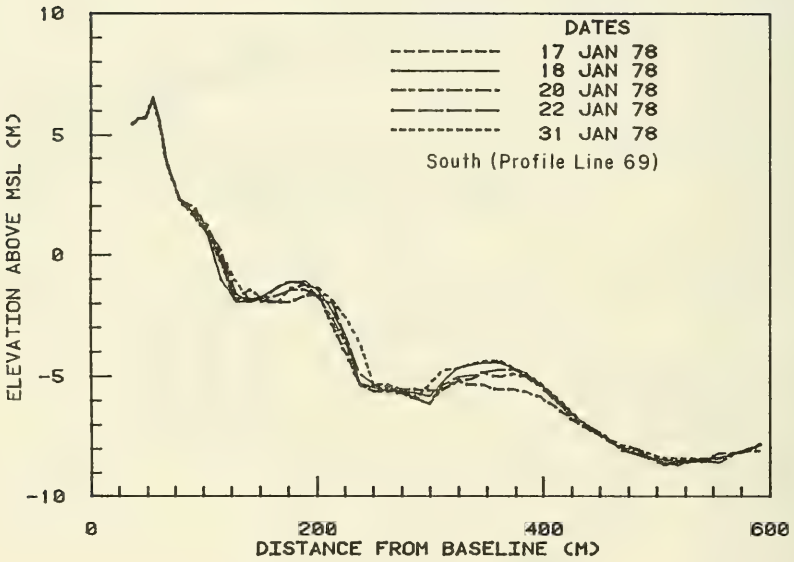
400
600
DISTANCE FROM BASELINE (M)


DATES
17 JAN 78
18 JAN 78
20 JAN 78
22 JAN 78
31 JAN 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
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200
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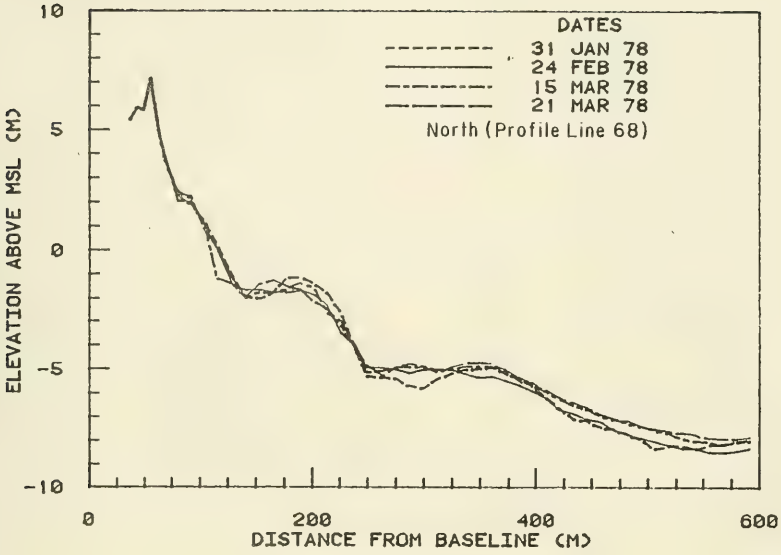
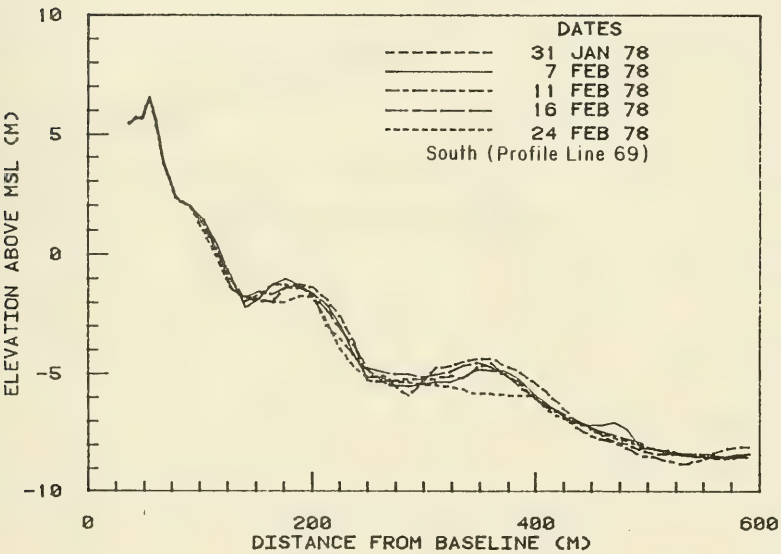
DISTANCE FROM BASELINE (M)


DATES
31 JAN 78
24 FEB 78
15 MAR 78
21 MAR 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
31 JAN 78
7 FEB 78
11 FEB 78
16 FEB 78
24 FEB 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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-5
-10
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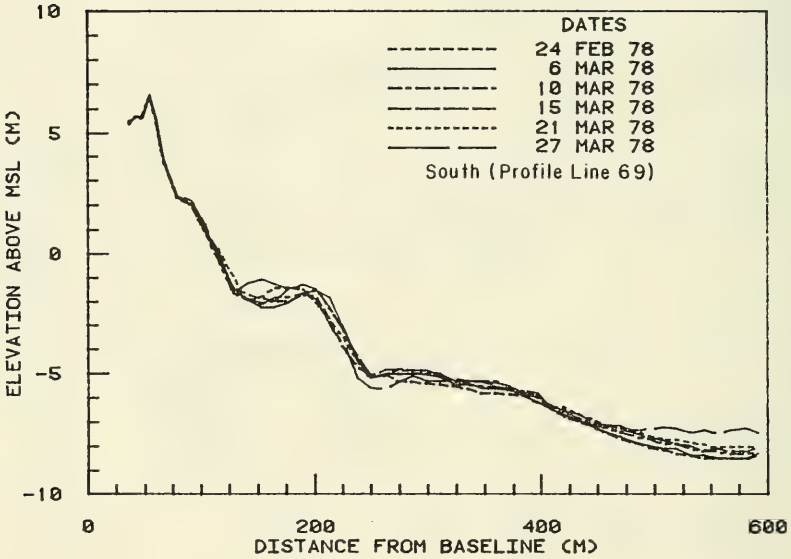
200
400
600
DISTANCE FROM BASELINE (M)


DATES
24 FEB 78
6 MAR 78
10 MAR 78
15 MAR 78
21 MAR 78
27 MAR 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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-5
-10
0
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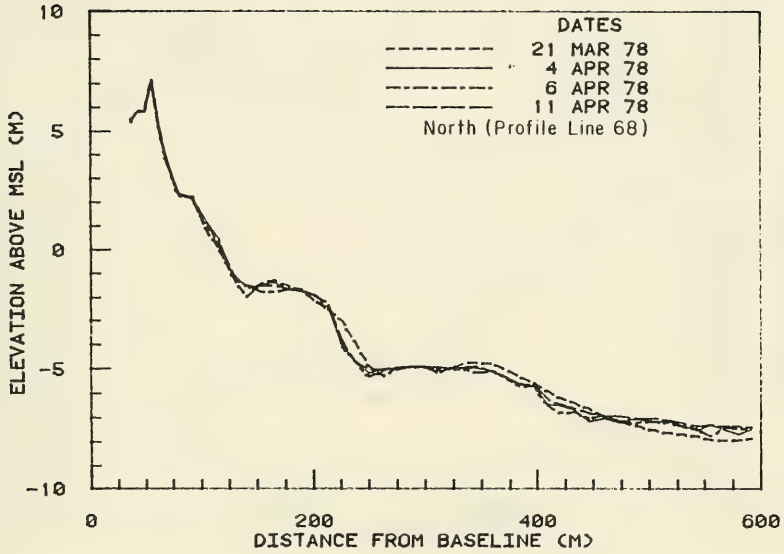
600
DISTANCE FROM BASELINE (M)


DATES
21 MAR 78
4 APR 78
6 APR 78
11 APR 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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-5
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0
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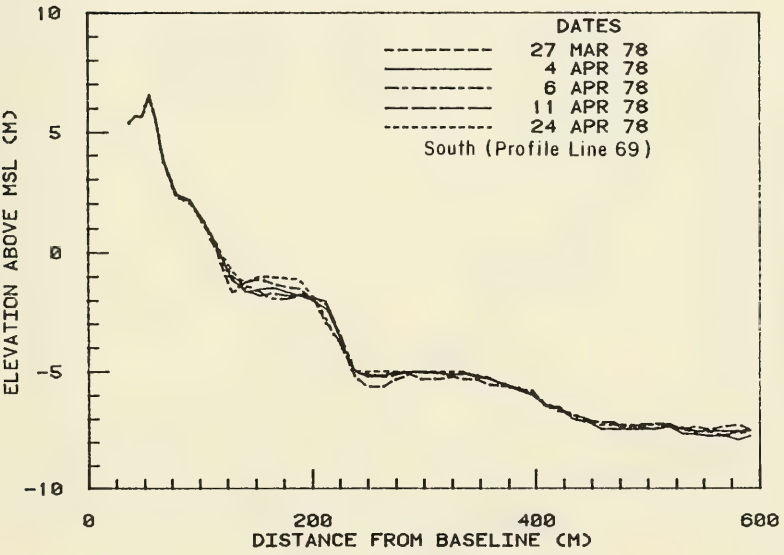
400
600
DISTANCE FROM BASELINE (M)


DATES
27 MAR 78
4 APR 78
6 APR 78
11 APR 78
24 APR 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
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-5
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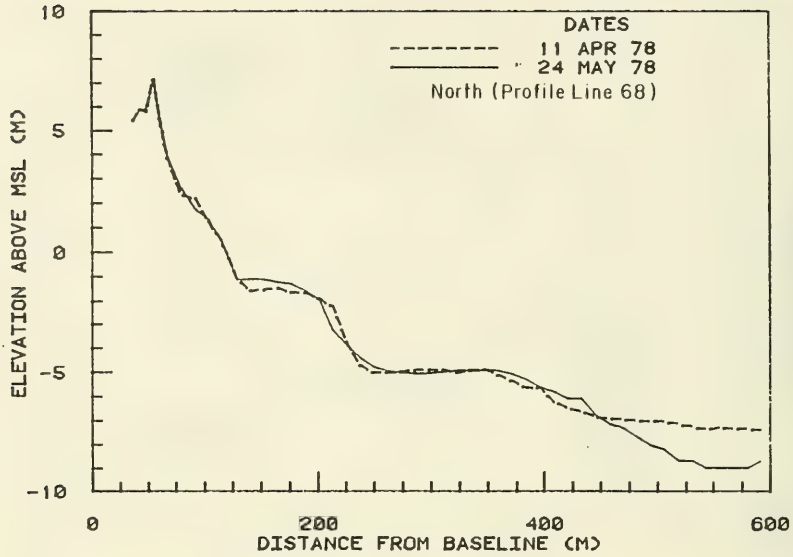
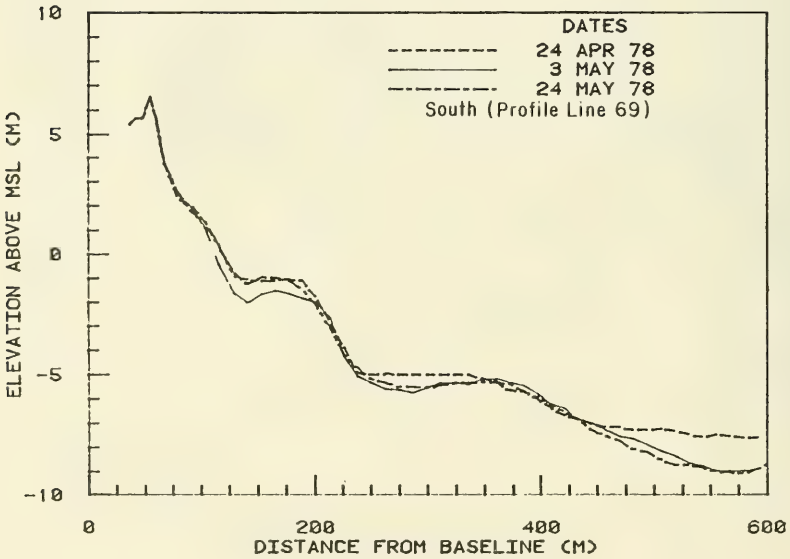
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
11 APR 78
24 MAY 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
24 APR 78
3 MAY 78
24 MAY 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
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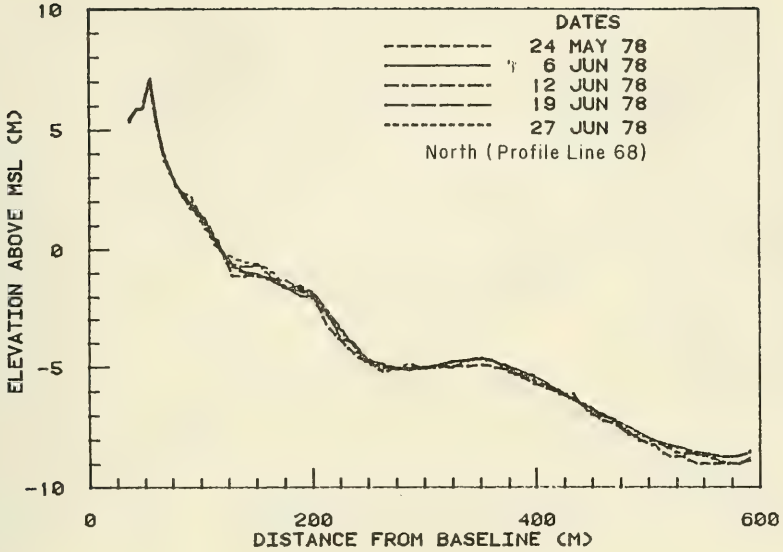
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
24 MAY 78
6 JUN 78
12 JUN 78
19 JUN 78
27 JUN 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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-5
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0
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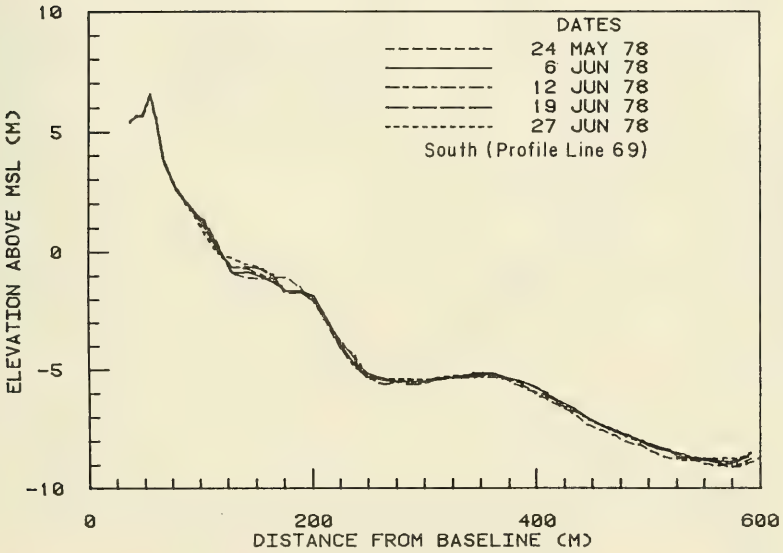
400
600
DISTANCE FROM BASELINE (M)


DATES
24 MAY 78
6 JUN 78
12 JUN 78
19 JUN 78
27 JUN 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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-5
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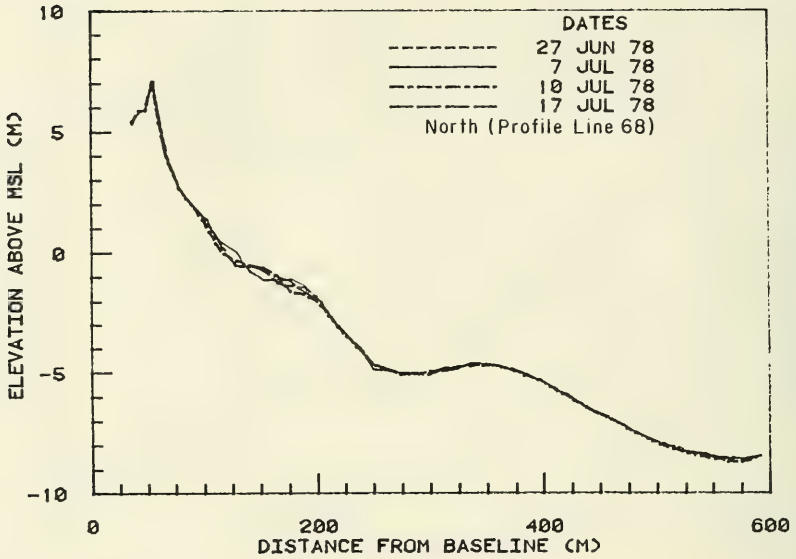
600
DISTANCE FROM BASELINE (M)


DATES
27 JUN 78
7 JUL 78
10 JUL 78
17 JUL 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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-5
-10
0
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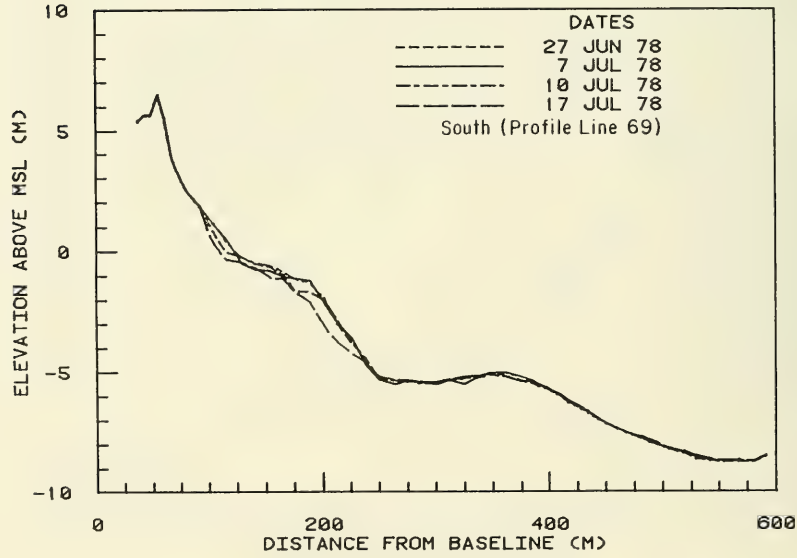
400
600
DISTANCE FROM BASELINE (M)


DATES
27 JUN 78
7 JUL 78
10 JUL 78
17 JUL 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
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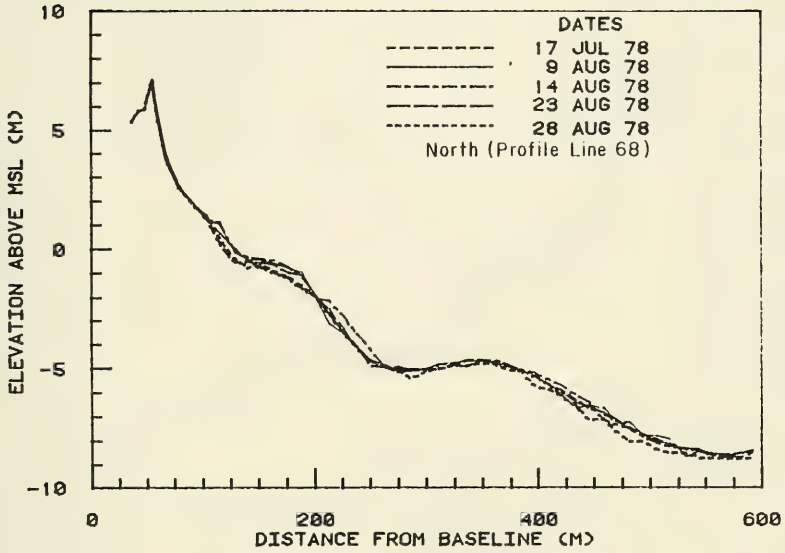
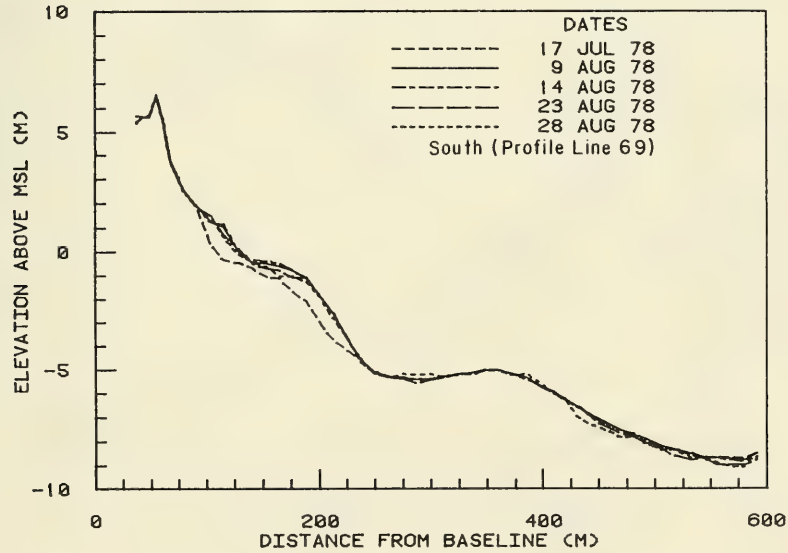
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
17 JUL 78
9 AUG 78
14 AUG 78
23 AUG 78
28 AUG 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
17 JUL 78
9 AUG 78
14 AUG 78
23 AUG 78
28 AUG 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
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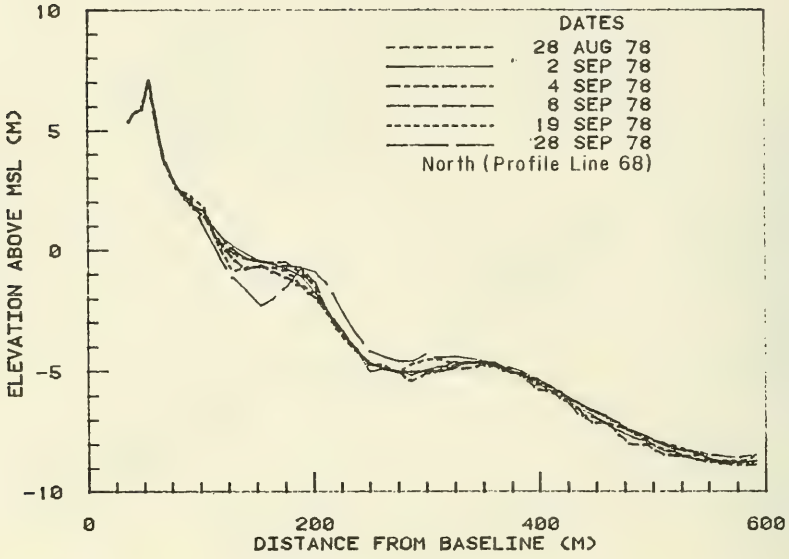
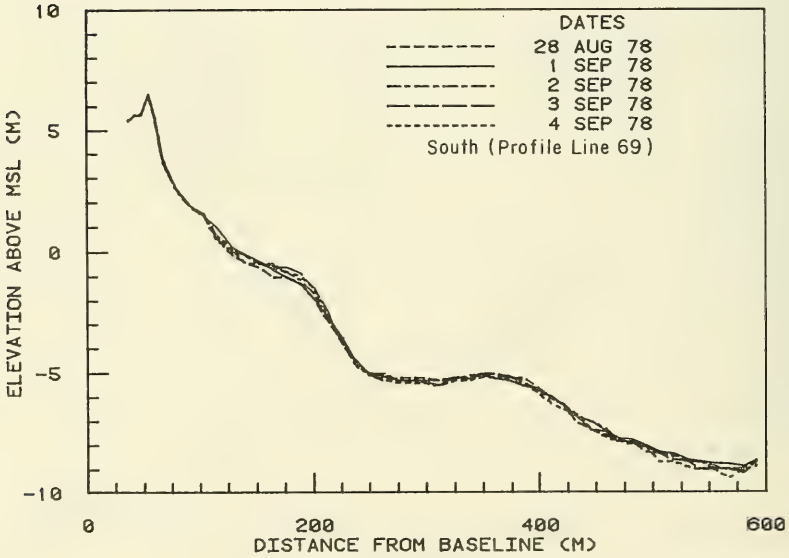
DISTANCE FROM BASELINE (M)


DATES
28 AUG 78
2 SEP 78
4 SEP 78
8 SEP 78
19 SEP 78
28 SEP 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
28 AUG 78
1 SEP 78
2 SEP 78
3 SEP 78
4 SEP 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
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200
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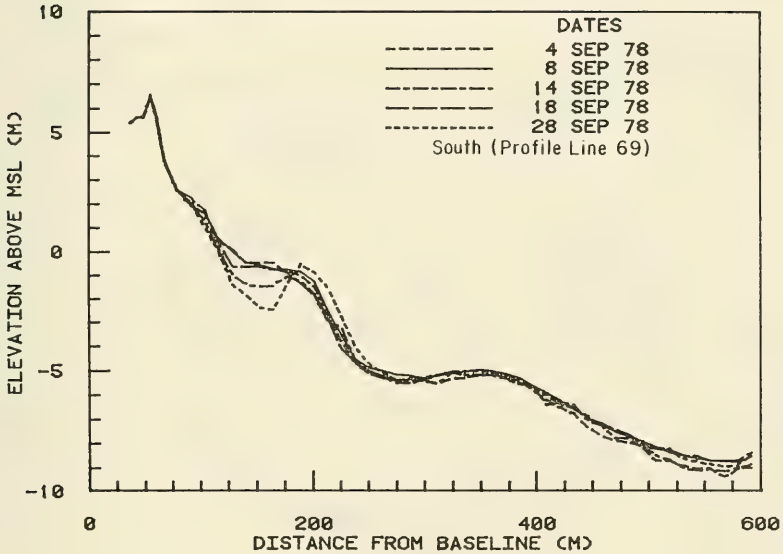
600
DISTANCE FROM BASELINE (M)


DATES
4 SEP 78
8 SEP 78
14 SEP 78
18 SEP 78
28 SEP 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
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-5
-10
0
200
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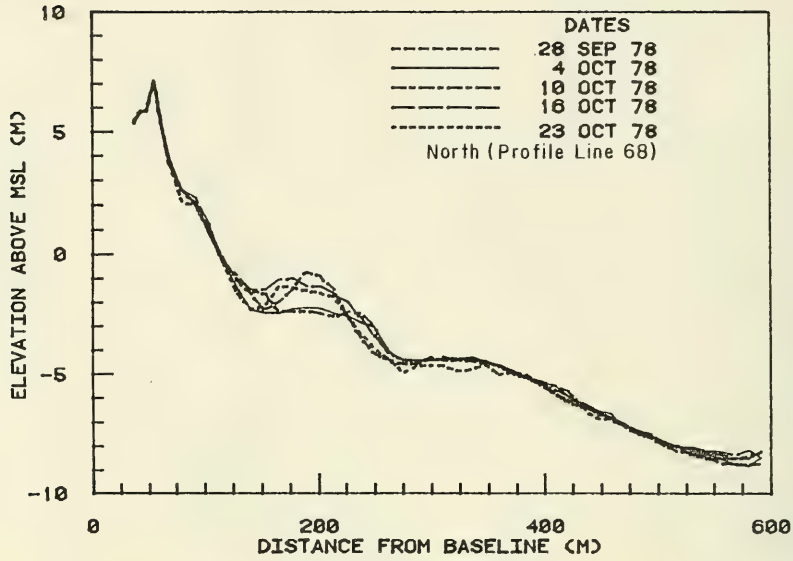
600
DISTANCE FROM BASELINE (M)


DATES
28 SEP 78
4 OCT 78
10 OCT 78
16 OCT 78
23 OCT 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
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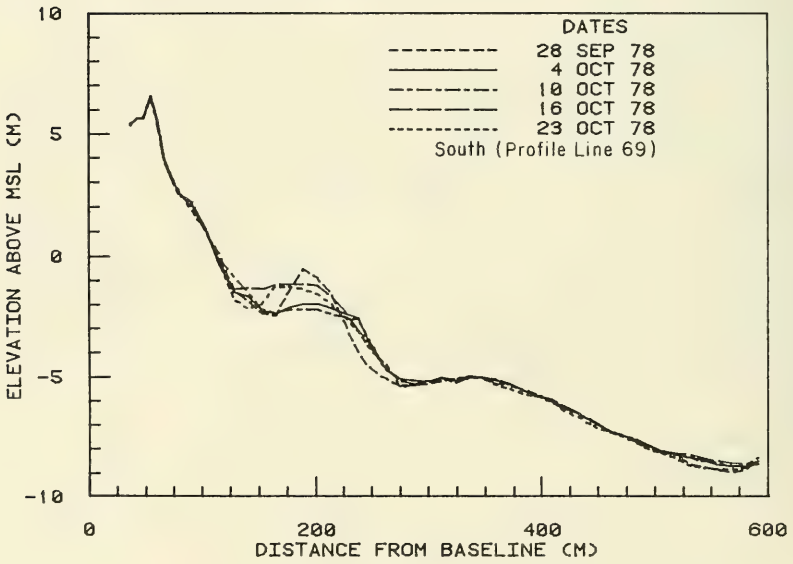
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
28 SEP 78
4 OCT 78
10 OCT 78
16 OCT 78
23 OCT 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
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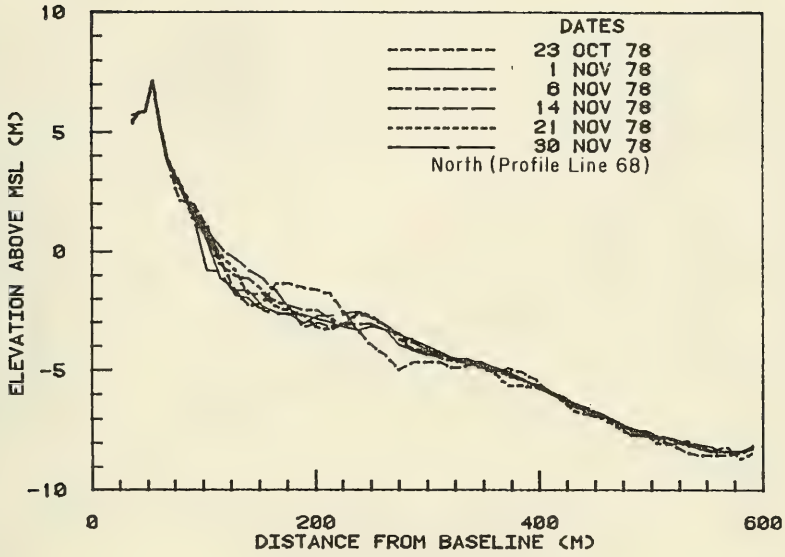
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
23 OCT 78
1 NOV 78
6 NOV 78
14 NOV 78
21 NOV 78
30 NOV 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
10
5
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-10
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200
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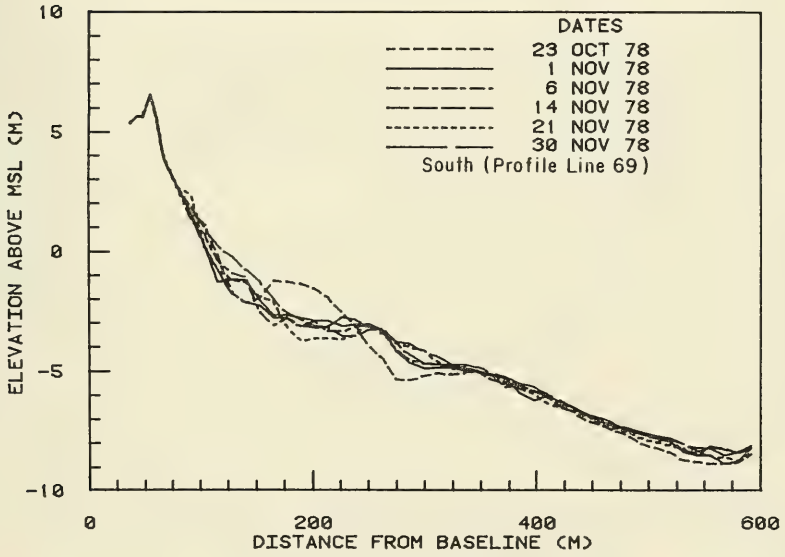
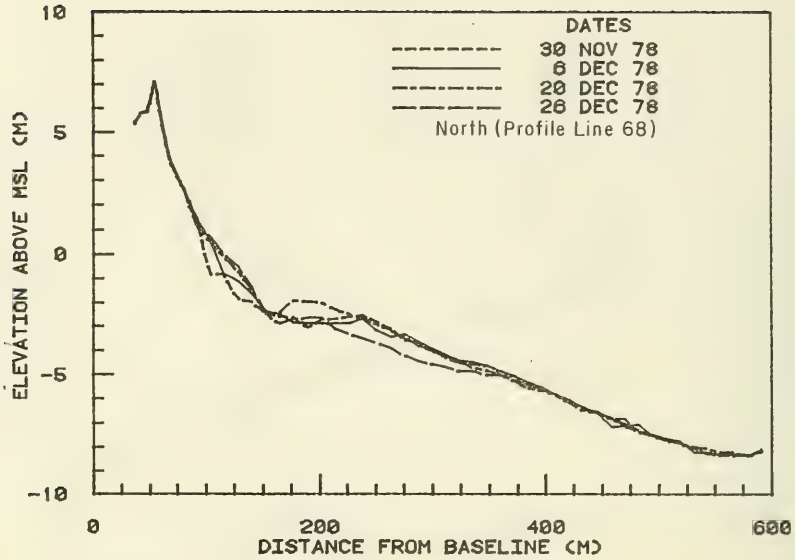
DISTANCE FROM BASELINE (M)


DATES
23 OCT 78
1 NOV 78
6 NOV 78
14 NOV 78
21 NOV 78
30 NOV 78
South (Profile Line 69)
ELEVATION ABOVE MSL (M)
10
5
0
-5
-10
0
200
400
600
DISTANCE FROM BASELINE (M)


DATES
30 NOV 78
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20 DEC 78
26 DEC 78
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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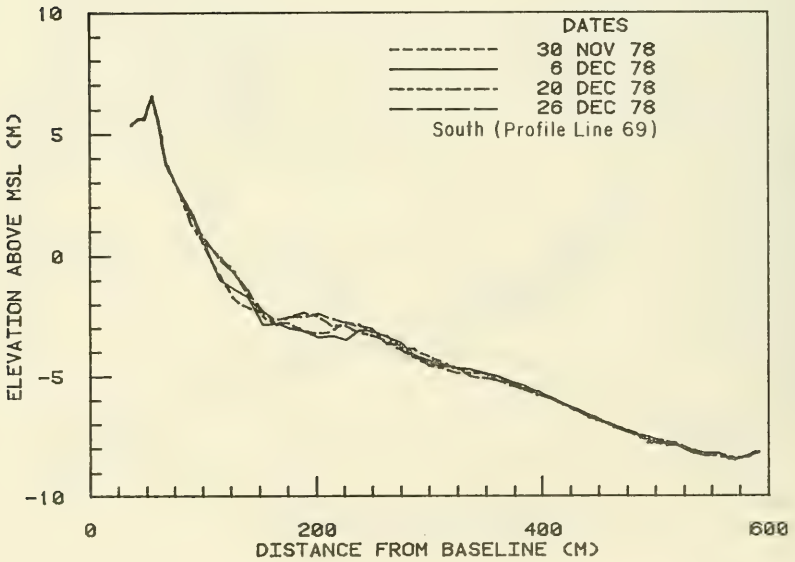
DISTANCE FROM BASELINE (M)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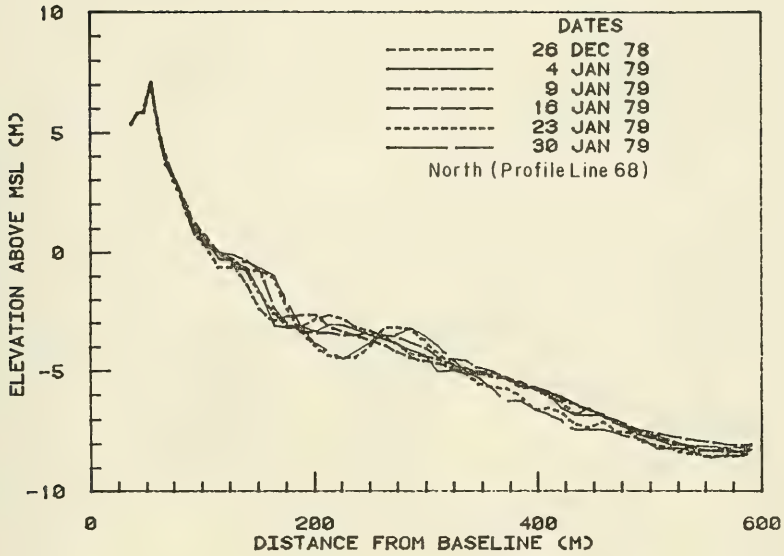
DISTANCE FROM BASELINE (M)


DATES
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North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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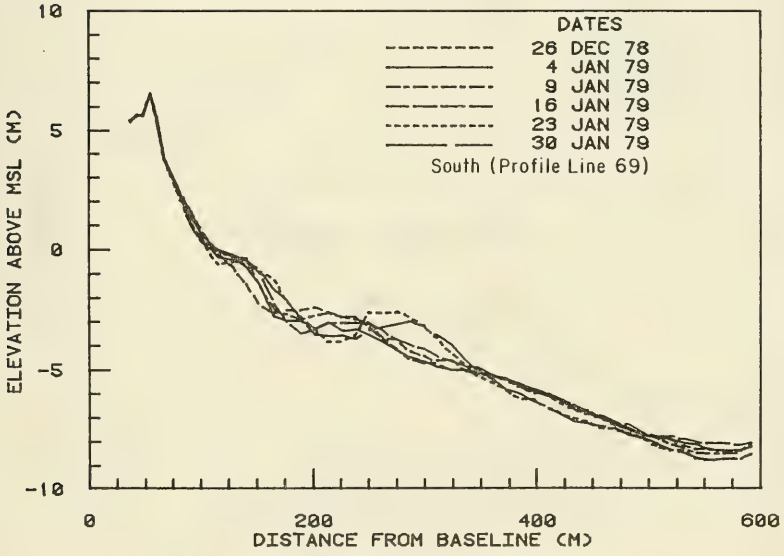
DISTANCE FROM BASELINE (M)


DATES
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South (Profile Line 69)
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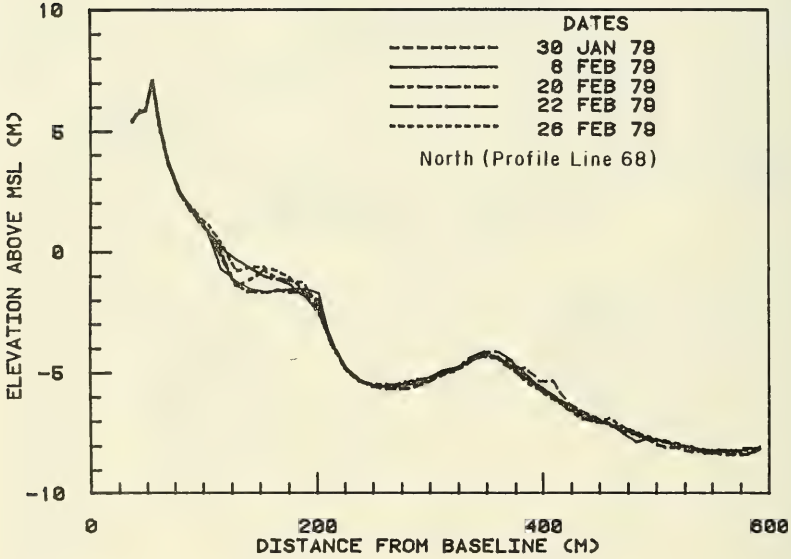
DISTANCE FROM BASELINE (M)


DATES
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North (Profile Line 68)
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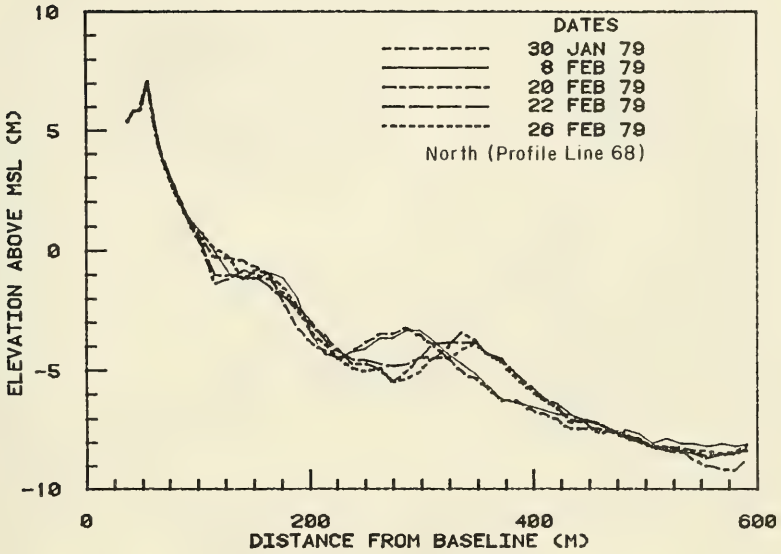
DISTANCE FROM BASELINE (M)


DATES
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North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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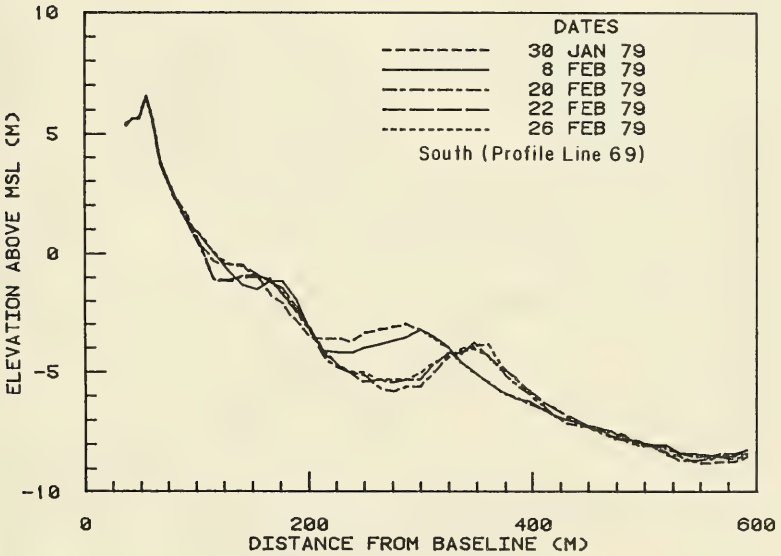
DISTANCE FROM BASELINE (M)


DATES
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South (Profile Line 69)
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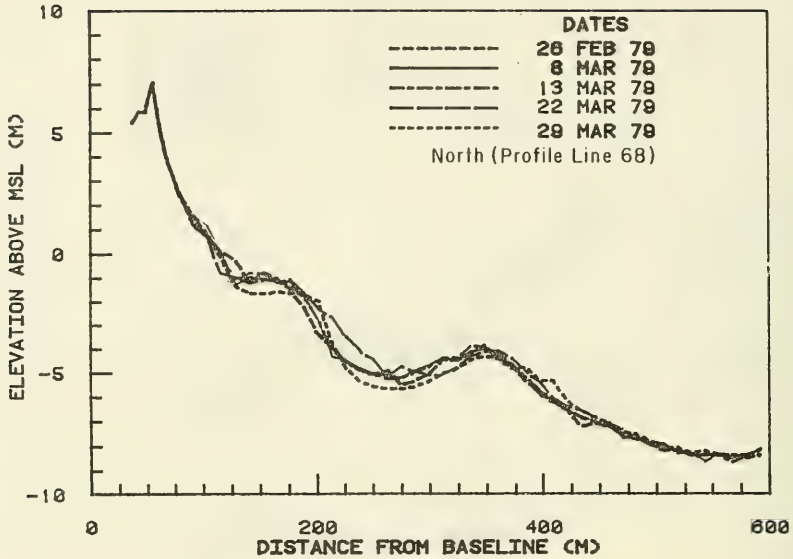
DISTANCE FROM BASELINE (M)


DATES
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13 MAR 79
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ELEVATION ABOVE MSL (M)
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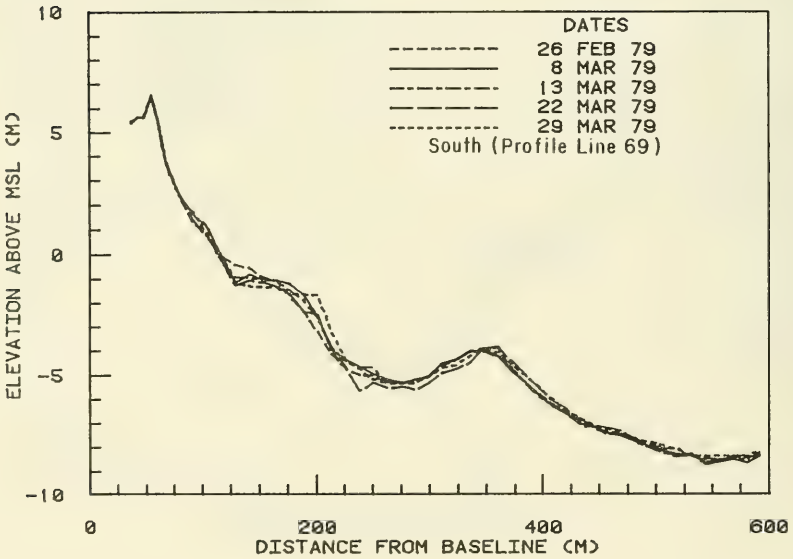
DISTANCE FROM BASELINE (M)


DATES
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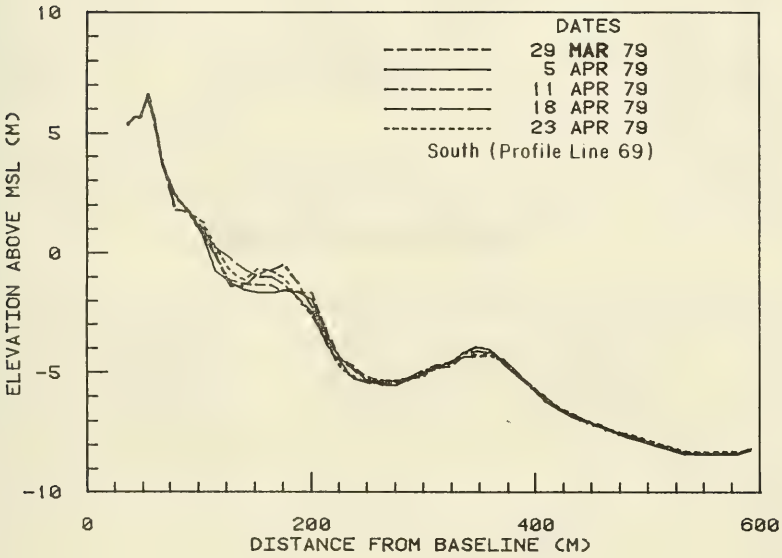
DISTANCE FROM BASELINE (M)


DATES
29 MAR 79
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South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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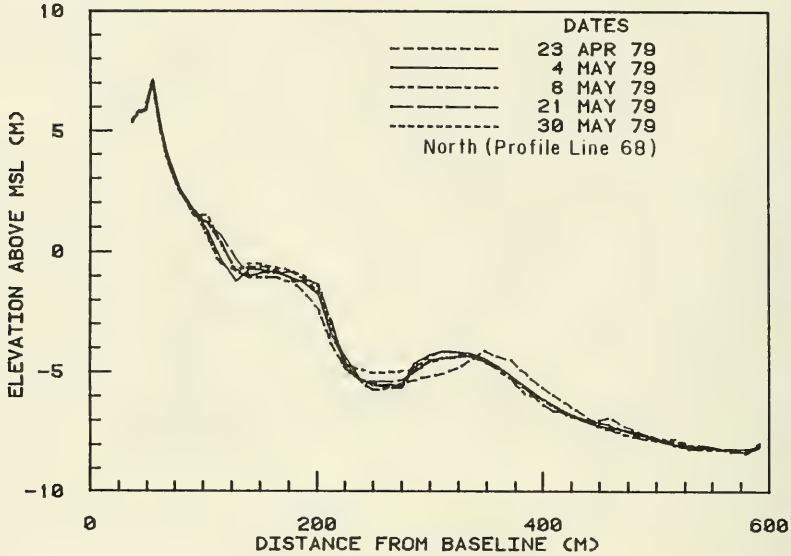
DISTANCE FROM BASELINE (M)


DATES
23 APR 79
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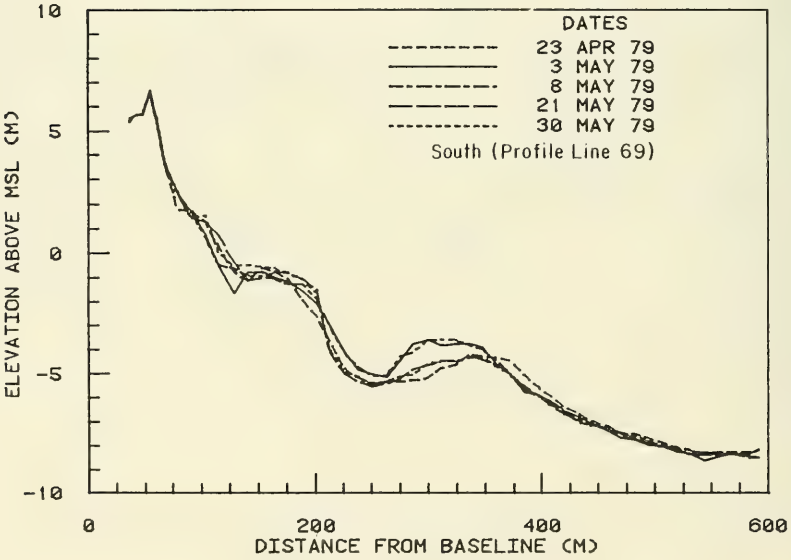
DISTANCE FROM BASELINE (M)


DATES
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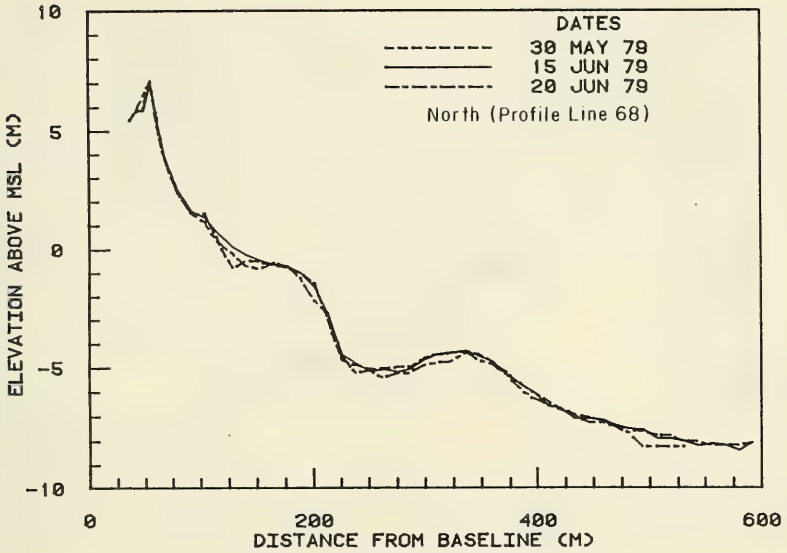
DISTANCE FROM BASELINE (M)


DATES
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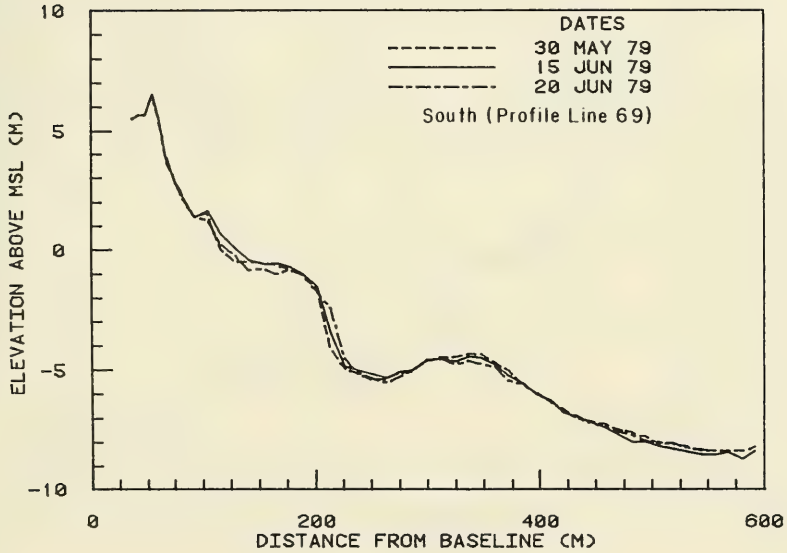
DATES
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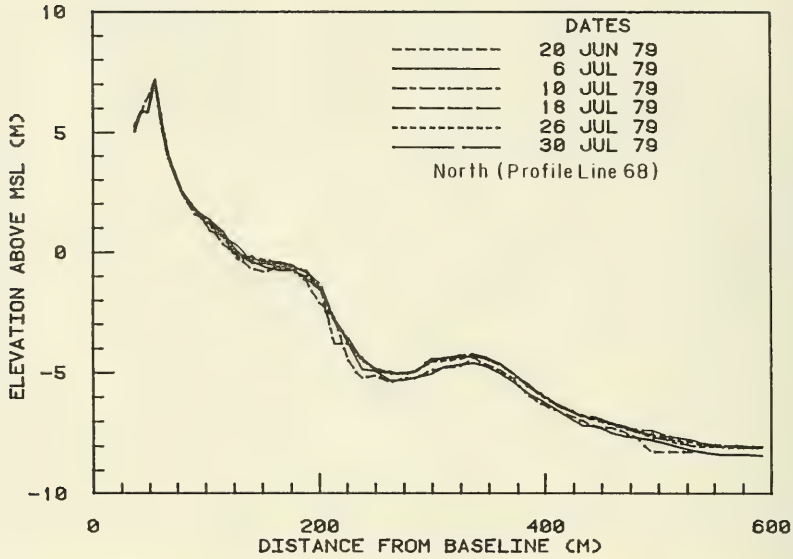
DISTANCE FROM BASELINE (M)


DATES
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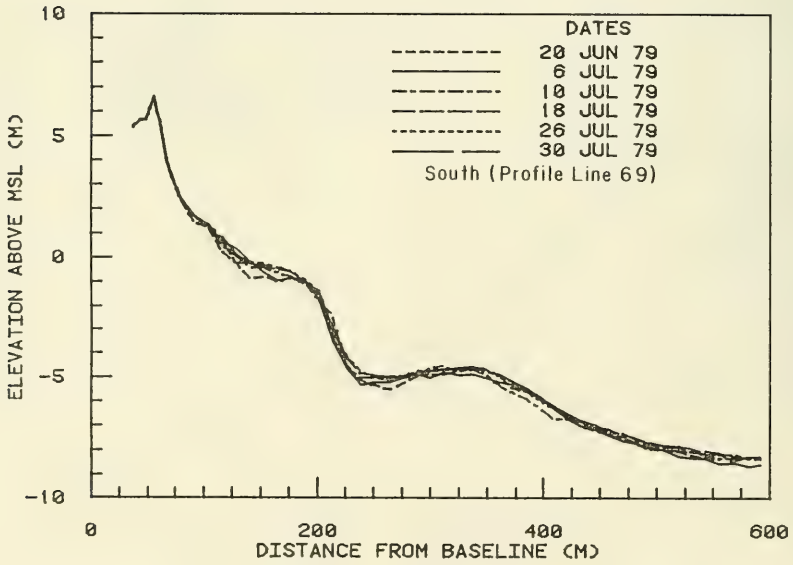
DISTANCE FROM BASELINE (M)


DATES
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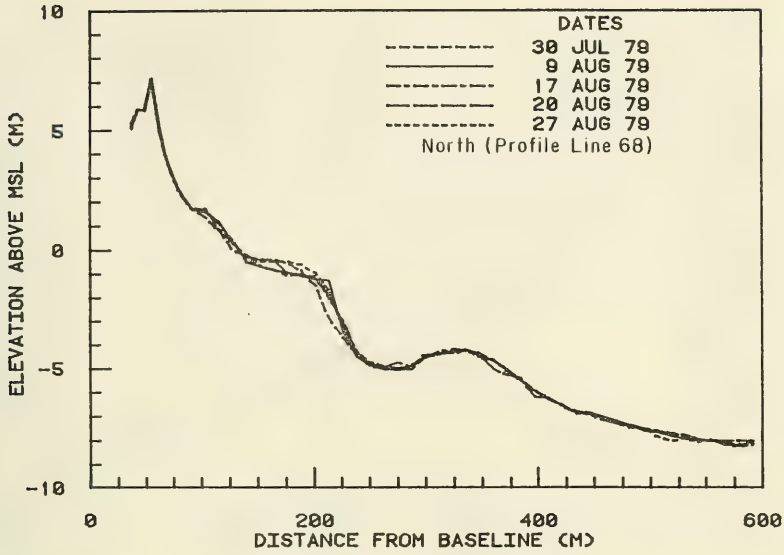
DISTANCE FROM BASELINE (M)


DATES
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North (Profile Line 68)
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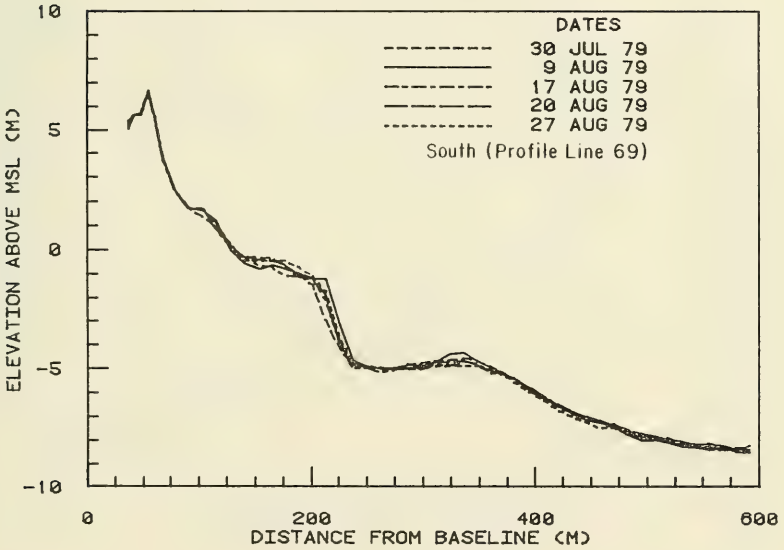
DISTANCE FROM BASELINE (M)


DATES
30 JUL 79
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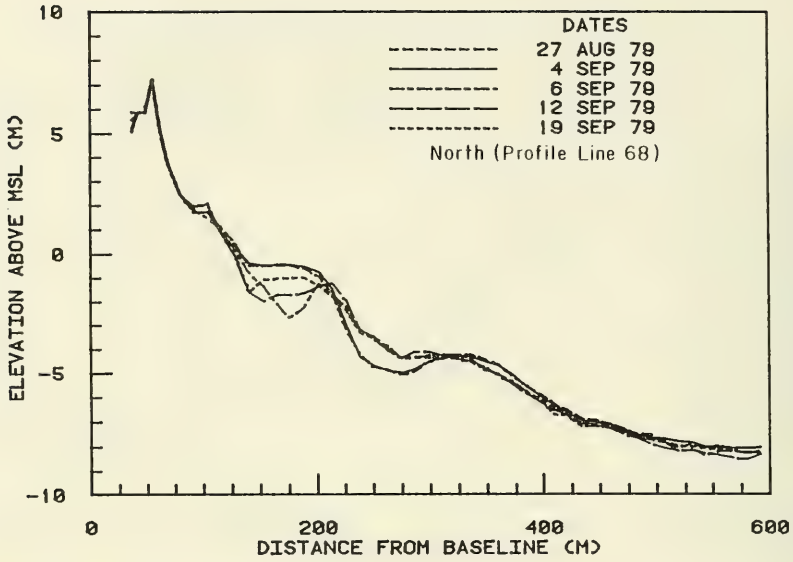
DISTANCE FROM BASELINE (M)


DATES
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6 SEP 79
12 SEP 79
19 SEP 79
North (Profile Line 68)
ELEVATION ABOVE MSL (M)
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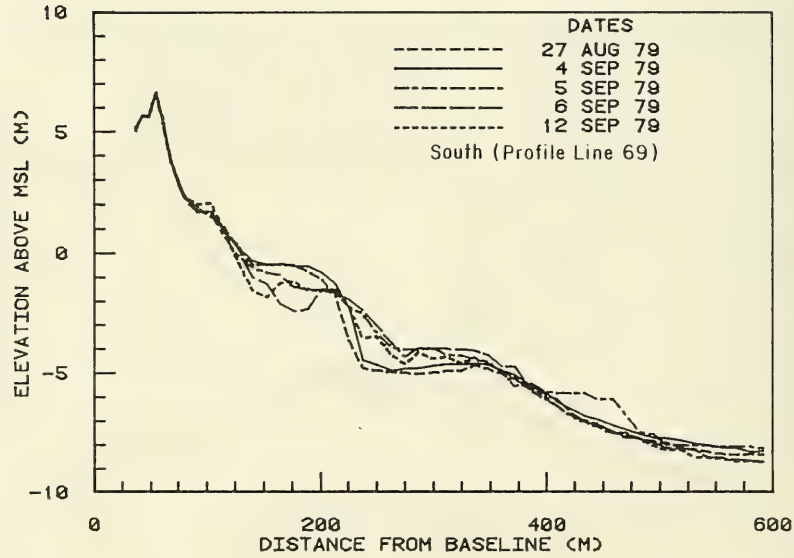
DISTANCE FROM BASELINE (M)


DATES
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South (Profile Line 69)
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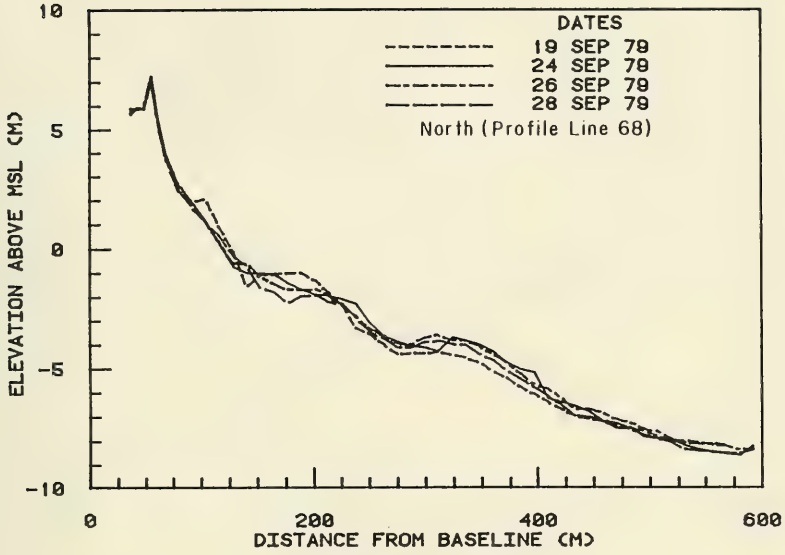
DISTANCE FROM BASELINE (M)


DATES
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24 SEP 79
26 SEP 79
28 SEP 79
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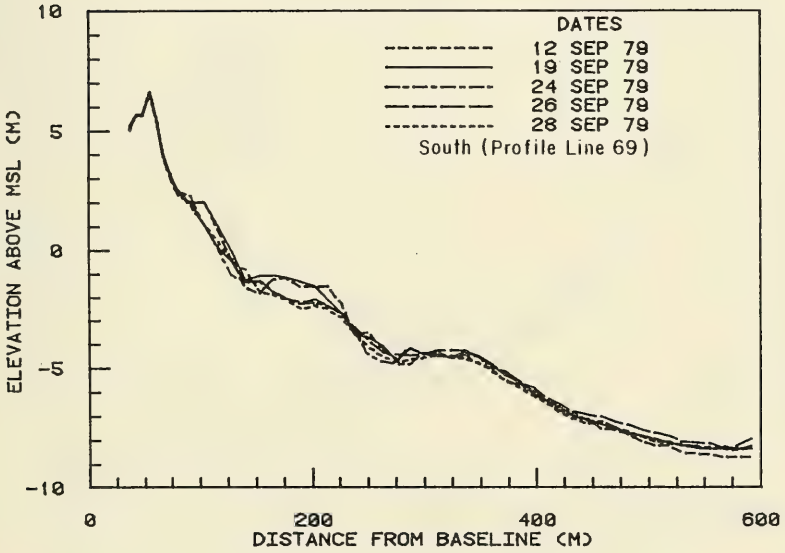
DISTANCE FROM BASELINE (M)


DATES
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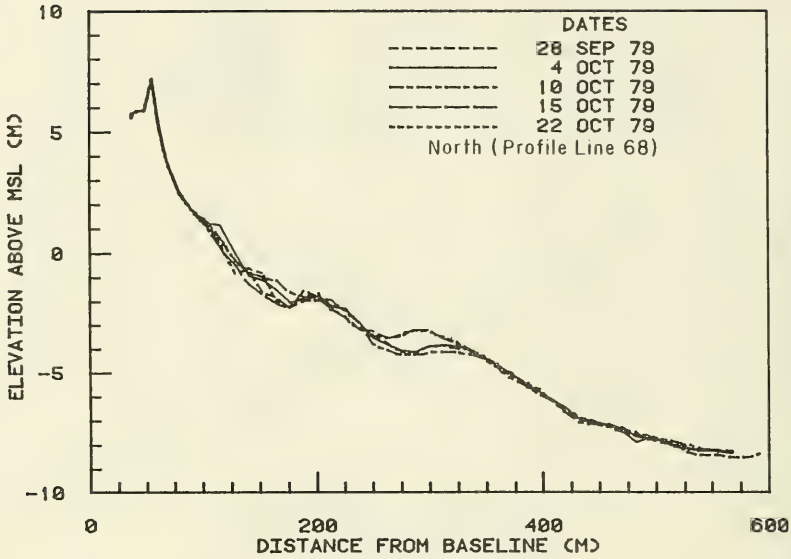
DISTANCE FROM BASELINE (M)


DATES
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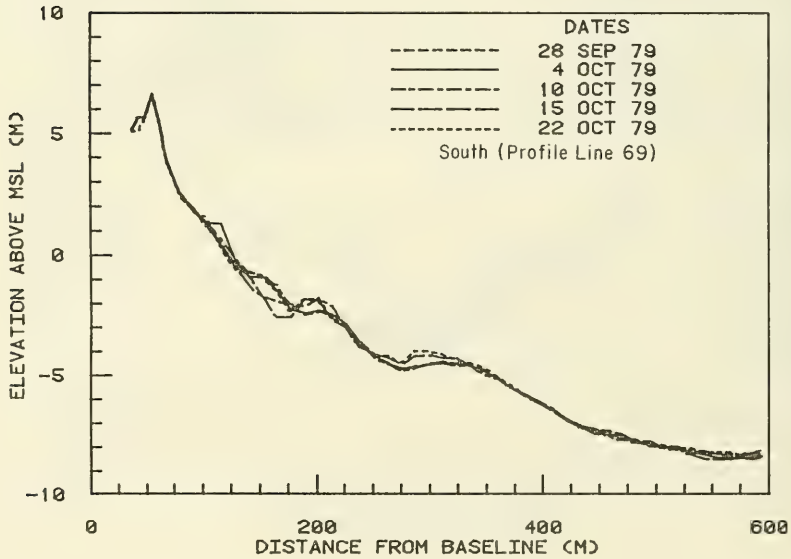
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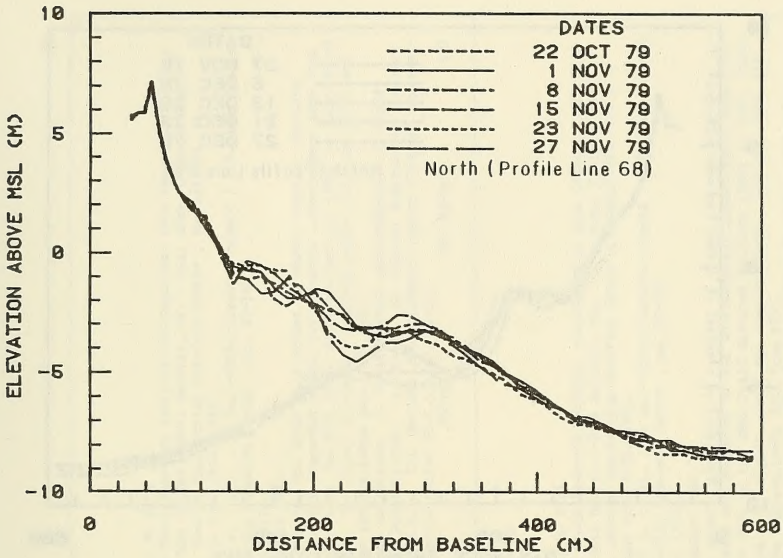
DATES
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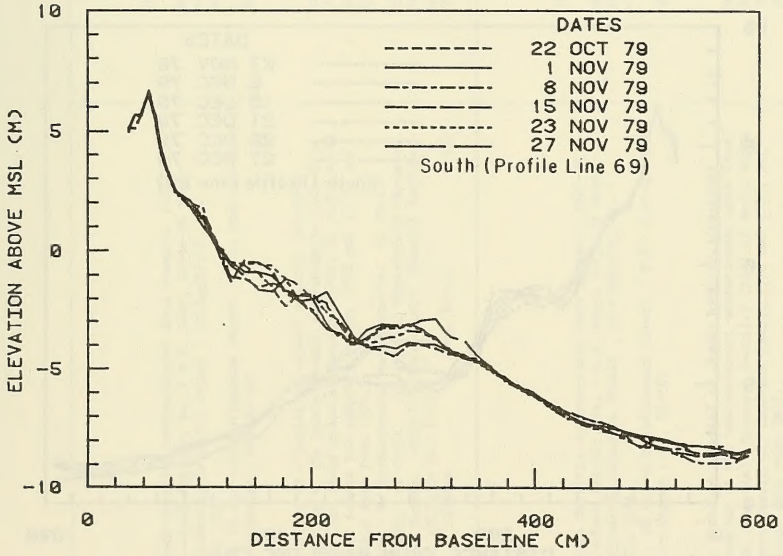
DATES
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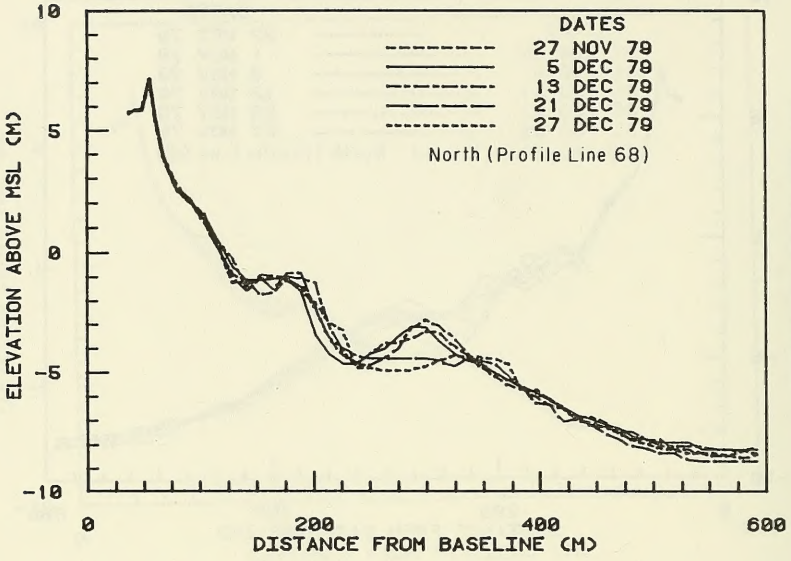
DATES
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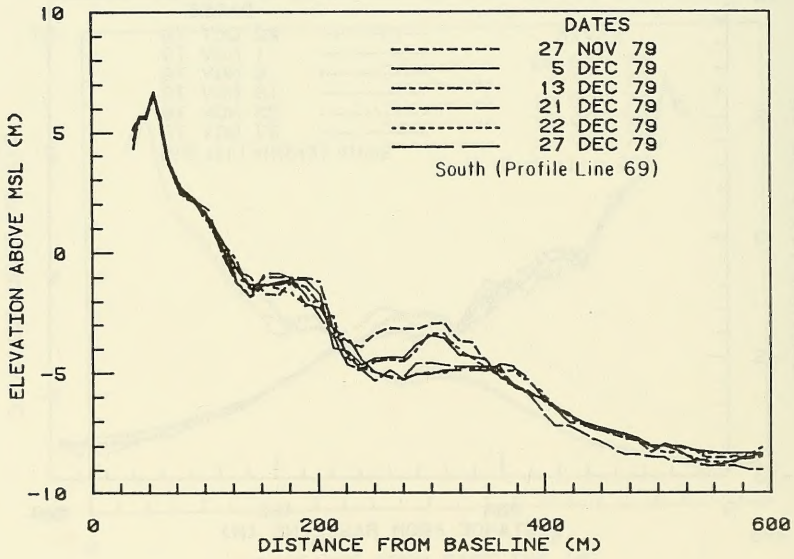
DISTANCE FROM BASELINE (M)


DATES
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South (Profile Line 69)
ELEVATION ABOVE MSL (M)
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DISTANCE FROM BASELINE (M)

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TC203 .U581mr no. 82-16 627

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